Aaberg Cultural Resource Consulting Service
2909 East MacDonald Drive Billings, MT 59102 phone/fax (406) 655-3540

THE RAINY CREEK SITE (24LN1045) DATA AND SIGNIFICANT INFORMATION RECOVERY REPORT AS PART OF THE SCREENING PLANT REMOVAL ACTION, LIBBY, MONTANA, ASBESTOS EMERGENCY RESPONSE PROJECT U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 8

Edited by
Stephen A. Aaberg

With contributions by:
William P. Eckerle, Patrick Walker-Kuntz, Chris Crofutt, Stephen A. Aaberg, Rebecca Hanna, Sasha Taddie, Robert U. Bryson, and Kristin Griffin

Prepared by:
Aaberg Cultural Resource Consulting Service
2909 East MacDonald
Billings, Montana 59102

Prepared for:
CDM Federal Programs Corporation
One Cambridge Place
50 Hampshire Street
Cambridge, Massachusetts 02139

April 2002

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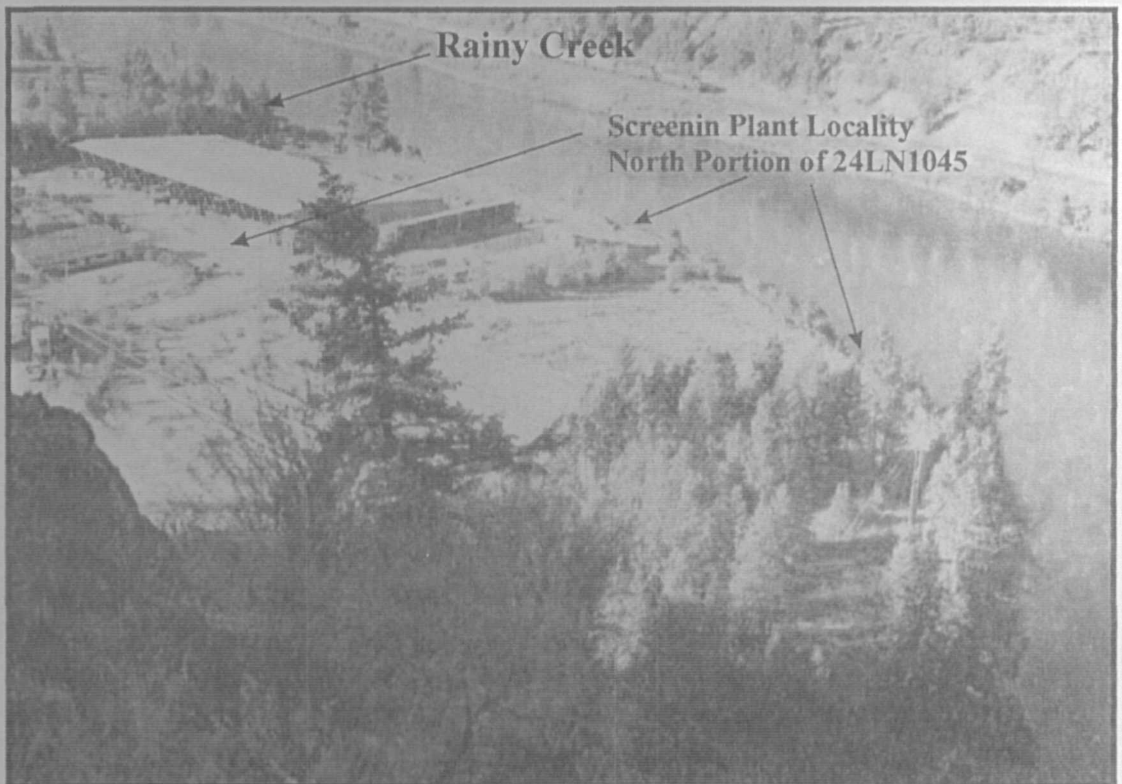
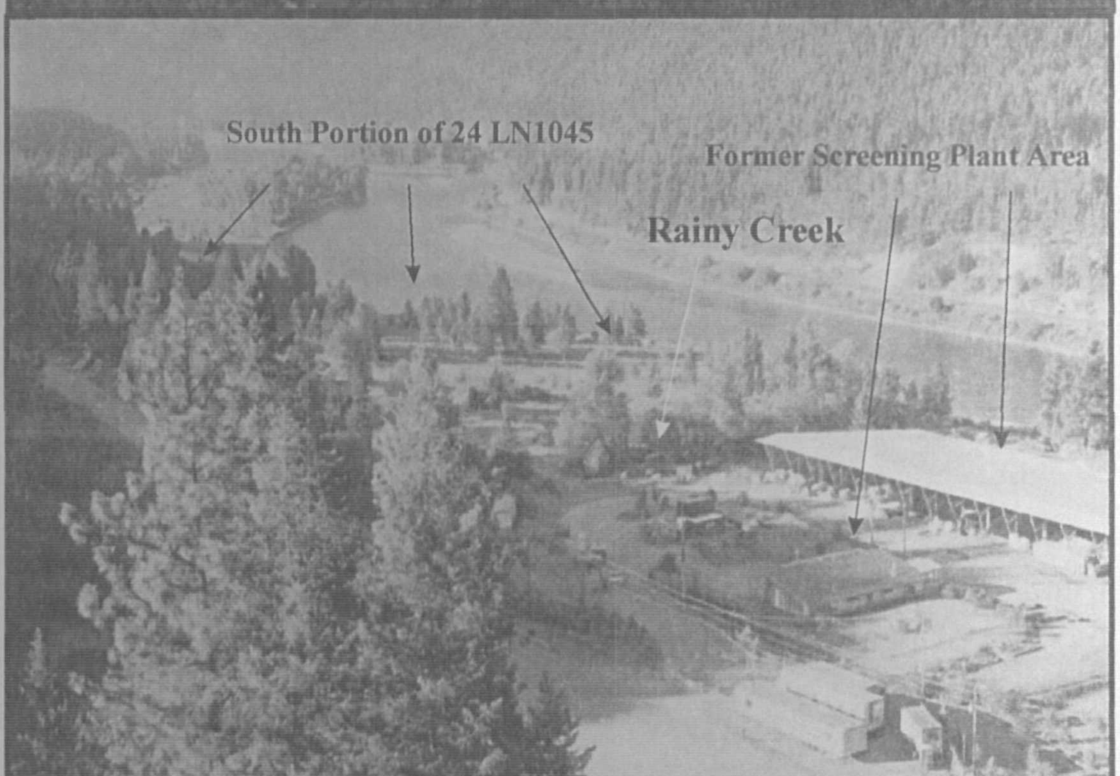
RAINY CREEK: Pre-remediation (7/2000)





See rear cover for post-remediation view

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INVENTORY LOCATION **PROPERTIES**

T	**R**	**S**	**Site Number**	**Property/Site Name**
31N	30W	32	24LN1045	Rainy Creek site

Attach to inventory report and send to: State Historic Preservation Office, Montana Historical Society, 1410 8th Avenue, PO Box 201202, Helena, MT 59620-1202

THE RAINY CREEK SITE (24LN1045) DATA AND SIGNIFICANT INFORMATION RECOVERY PLAN REPORT AS PART OF THE SCREENING PLANT REMOVAL ACTION LIBBY, MONTANA ASBESTOS EMERGENCY RESPONSE PROJECT U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 8

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ACKNOWLEDGEMENTS

From the start, the data and significant information recovery project at 24LN1045 presented many challenges relating to its association with the Libby Asbestos Emergency Response Project. ACRCS came to rely on a number of people and firms associated with the asbestos project to overcome many obstacles faced during archaeological fieldwork and research. Of invaluable assistance, was Peter Boroweic of CDM Federal Programs, Inc., who served as a liaison between ACRCS and myriad other firms and agencies. Peter set up the HAZWOPER training session for the ACRCS field crew, was the "pipeline" to various other firms, agencies, and administrators, served as a "rod man" during some survey mapping events, provided aerial photographs, site photographs, and site maps, processed invoices, and answered many contract questions. Many other CDM staff members assisted ACRCS during the project.

MARCOR and their field staff at the old W.R. Grace screening plant locality got ACRCS through health and safety issues and requirements and also provided various equipment that was needed to accomplish archaeological fieldwork within a hazardous material containment area. John McGuiggin of the Volpe Center also assisted ACRCS in negotiating through some sensitive administrative issues. Jude Hopza, "on loan" from the Army Corps of Engineers to the EPA, was the screening plant remediation coordinator and was present at the site the entire time ACRCS was in the field. Jude, more than anyone else, enabled ACRCS to overcome a number of data recovery obstacles encountered while excavating in a contaminated containment area.

Mark White, Libby area historian, and ranger district archaeologist with the Kootenai Forest, graciously opened his personal library of historical documents, maps, and books, to ACRCS. Mark also shared his personal knowledge, which is substantial, of the history of the Libby and Rainy Creek areas. Rebecca Timmons, Kootenai Forest archaeologist, provided copies of previous archaeological reports relevant to the Kootenai River area and shared personal information on area archaeological research. Tim Light, Forest Service archaeologist in Kalispell, facilitated use of a Forest Service conference room for a meeting between ACRCS and Rainy Creek property owners, Mel and Lerah Parker. Tim also attended the meeting and addressed questions the Parkers had with respect to artifact ownership and curation. Mel and Lerah Parker have endured more than any human beings should through this project, losing their home and business because of asbestos contamination. Through it all, they cheerfully communicated with ACRCS and are attempting to arrange for some form of artifact curation for materials recovered from their property.

Lorraine Caye, Kutenai cultural representative with the Salish-Kutenai THPO, and also Kutenai liaison with the Kootenai Forest, stayed in regular communication with ACRCS and elaborated on Kutenai cultural concerns with the project. Marcia Pablo, Salish-Kutenai tribal historic preservation officer, also communicated regularly with ACRCS and was clear about her concerns with the 106 process associated with the project.

Stephen A. Aaberg - ACRCS
Principal Investigator
April 5, 2002

ABSTRACT

Region 8 of the United States Environmental Protection Agency (EPA-8) is directing and coordinating removal and remediation activities associated with the Libby, Montana Asbestos Emergency Response Project in Lincoln County in northwestern Montana. This remediation began in the summer of 2000 and included removal of asbestos contaminated soil from the property using heavy equipment for stripping and excavation. Although soil stripping removed an average of 18" of sediment from the surface, pockets of contaminated sediment were found to occur upwards of 10 feet below surface. Soil removal required use of trucks to transport contaminated soils to a disposal site.

Archaeological site 24LN1045 (The Rainy Creek Site) occupies essentially all of the asbestos-affected area. The site is bisected by Rainy Creek, with the Kootenai River on the west, and Highway 37 on the east (a small portion of 24LN1045 extends to the east side of Highway 37). Asbestos contamination sampling and testing carried out in late spring and early summer of 2000 indicates that this hazardous material has contaminated essentially the entire site. Thus, the entire site will be partially or completely destroyed or disturbed by removal of contaminated soil. Because 24LN1045 had been recommended as eligible for listing in the National Register of Historic Places, and because the EPA is directing and coordinating removal and remediation of the Libby Asbestos Project, various cultural resource federal laws and statutes mandate consideration of potential impacts to this archaeological site. The primary contractor for the project, CDM, subcontracted with Aaberg Cultural Resource Consulting Service (ACRCS) who, among other tasks, drafted recommendations for archaeological and cultural mitigation activities (plan for recovery of significant information) for site 24LN1045. ACRCS was subsequently contracted by CDM to carry out site mitigation and data recovery at 24LN1045.

The EPA, through its contractors and subcontractors, had already begun preliminary fieldwork and analyses associated with remediation of the old vermiculite processing locality prior to the 2000 archaeological investigations. Because of the emergency nature of the Libby Asbestos Project and the extreme threat to human health posed by asbestos contamination, all personnel entering the old W.R. Grace screening plant locality (where 24LN1045 is located), including all archaeological crew members, were required to go through Office of Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) training. After completing HAZWOPER training, a field crew from ACRCS carried out archaeological excavation and investigation of 24LN1045 beginning on August 27 and continuing through the third week of September 2000.

Nine square meters of hand excavation, amounting to 8.7 cubic meters of sampled deposits, were accomplished during the Rainy Creek Site investigations in 2000. Investigations were augmented by emplacement of nine backhoe trenches encompassing 545 square meters. Occupations dating from about 2000 years ago and extending to the protohistoric period were documented in the hand-excavated units. Two additional occupations dating to about 2800 years ago and 3700 years ago were identified in two backhoe trenches but were not hand sampled.

The material culture record of 24LN1045 documents occupation of the locality at least to about 3720 years ago. The site was repeatedly occupied during this period and occupation continued up to historic times, with K'tunaxa/Kutenai Indians unquestionably among site occupants. Most occupations appear to have been relatively intense and most are characterized by large quantities of "deer-like" bone and heat-altered rock. Preliminary indications from two deeply buried cultural strata suggest a similar emphasis on deer procurement and processing. The high frequency of heat-altered rock may be associated with particular deer processing activities. Roasting of meat is indicated by the presence of two cultural features identified as roasting platforms. Highly fractured bone, along with highly fractured heat-altered rock suggests that stone boiling was a common activity and likely included production of bone grease and extraction of marrow. Presence of hunting tools, like projectile points, indicates game procurement was as much a part of site activities as game processing. The high frequencies of disk knives or disk tools, which were strongly associated with areas containing large quantities of butchered bone and heat-altered rock, indicates that these tools were important in some aspect (or aspects) of game processing (e.g. hide scraping, meat cutting and deboning). Although only a single bone tool (an awl) was recovered, it indicates that hide-working was carried out at the site. Presence of grinding tools, along with plant residues found on several artifacts, suggests that some plant (likely seeds) processing also occurred at the site. In short, at 24LN1045, there appears to have been a focus on deer procurement and processing from about 3700 years ago to the protohistoric era. The extremely fragmentary condition of the bone suggests that these animals were thoroughly and completely utilized with absolutely no wastage.

There has been much speculation that Rainy Creek was the location of one or more historic fur trading posts. Several references place the location of those posts on the south side of Rainy Creek. Although 2000 excavations were limited, excavation units were placed throughout the south portion of the site and a large part of this area was heavy-equipment-stripped and was monitored by ACRCS. Artifacts associated with the fur trade era were not found. A blue glass trade bead found south of Rainy Creek exhibits evidence of having been strung and worn and most likely associates with a historic Kutenai Indian occupation. Trading posts are known to have been the focus of varied activity and if occupied for any length of time have been demonstrated to contain dense and varied historic debris and artifacts. Historic artifacts post-dating 1900 were found during monitoring and they likely associate with the Ben Thomas residence. It therefore seems extremely unlikely that a fur trading post was ever located at Rainy Creek for any length of time. It is possible that evidence of the fur trade era was destroyed by vermiculite processing activities that began in the 1930s. The north side of Rainy Creek was particularly ravaged by these developments, and the south side did not escape substantial disturbance.

While it appears that most of the densely occurring occupational zones have been completely obliterated by asbestos remediation, some cultural deposits remain intact, sealed beneath fill brought in by EPA subcontractors as part of post-remediation reclamation. Two deep culture-bearing strata likely survived remediation on the south side of Rainy Creek. These strata are sealed and well separated from other occupations. As such, they represent important cultural deposits that could address many questions on settlement and subsistence during the Middle Prehistoric Period. Other investigators experienced problems of stratigraphic *separation of multiple occupations covering long periods. The deep culture-bearing strata at Rainy Creek therefore offer unusual potential for examining discrete cultural occupations.*

One excavation unit was placed on a remnant of a T1 terrace at the site. It is not known if this remnant survived asbestos remediation. If it did, this area also offers great research potential. Intact and discrete Late Prehistoric Period and Protohistoric occupations were identified in this area. Further excavations here could lead to associating particular projectile points, other tools, and particular lithic material types with the K'tunaxa/Kutenai Indians. Their presence is documented by recovery of a blue grass trade bead and exposure of a cultural feature dated to about 320 years ago.

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

INTRODUCTION

by
Stephen A. Aaberg

Project Understanding

Region 8 of the United States Environmental Protection Agency (EPA-8) is directing and coordinating removal and remediation activities associated with the Libby, Montana Asbestos Emergency Response Project which is located in Lincoln County in northwestern Montana (Figures 1, 2 and 3). The Environmental Engineering Division (DTS-33) of the John A. Volpe National Transportation Systems Center (Volpe Center) is providing environmental engineering and contaminant removal support to the EPA-8. The Volpe Center and their contractor, CDM Federal Programs Corporation (CDM) and it's subcontractor, Pacific Environmental Services, Inc. (PES), along with the Volpe Center's removal/demolition contractor, MARCOR Remediation, Inc. (MARCOR), began remedial action associated with Libby area asbestos contamination in the summer of 2000.

The Libby Asbestos Project included time critical removal actions at two locations of the Libby Asbestos Site (the site). One of those locations is termed Operable Unit 02 and is the locus of the former W.R. Grace Screening Plant (Screening Plant). Operable Unit 02 occurs on the east side of the Kootenai River at its confluence with Rainy Creek in the NE1/4 of Section 32, T31N, R30W in Lincoln County, Montana (Figures 1, 2 and 3).

Remediation activities at Operable Unit 2 generally included removal of contaminated soil from areas, determined through surface soil sampling, to contain asbestos. This remediation included removal of asbestos contaminated soil from property located on both sides of Rainy Creek. Although soil stripping removed an average of 18" of sediment from the surface, pockets of contaminated sediment were found to occur upwards of 10 meters below surface. Soil removal required use of heavy equipment for stripping and excavation and use of trucks to transport contaminated soils to a disposal site.

Archaeological site 24LN1045 (The Rainy Creek Site) occupies essentially all of Operable Unit 2 (Figures 3, 4, 5, 6 and 7) and is located on parts of the privately owned Parker, Wise, and Owens properties. The site is bisected by Rainy Creek, with the Kootenai River on the west, and Highway 37 on the east (a small portion of 24LN1045 extends to the east side of Highway 37). Asbestos-contaminated soils encompassed the entire boundary of 24LN1045. Therefore the entire surface of 24LN1045 was be affected by soil removal. As of the time of preparation of this report, a portion of the site (south end) had not undergone soil stripping and asbestos remediation. The Kootenai Development Corporation owns this portion of the site. Because 24LN1045 had been recommended as eligible for listing in the National Register of Historic Places (Griffin and Aaberg 1994), and because the EPA is directing and coordinating removal and remediation of the Libby Asbestos Project, consideration of potential impacts to this archaeological site are mandated by various cultural resource federal laws and statutes.

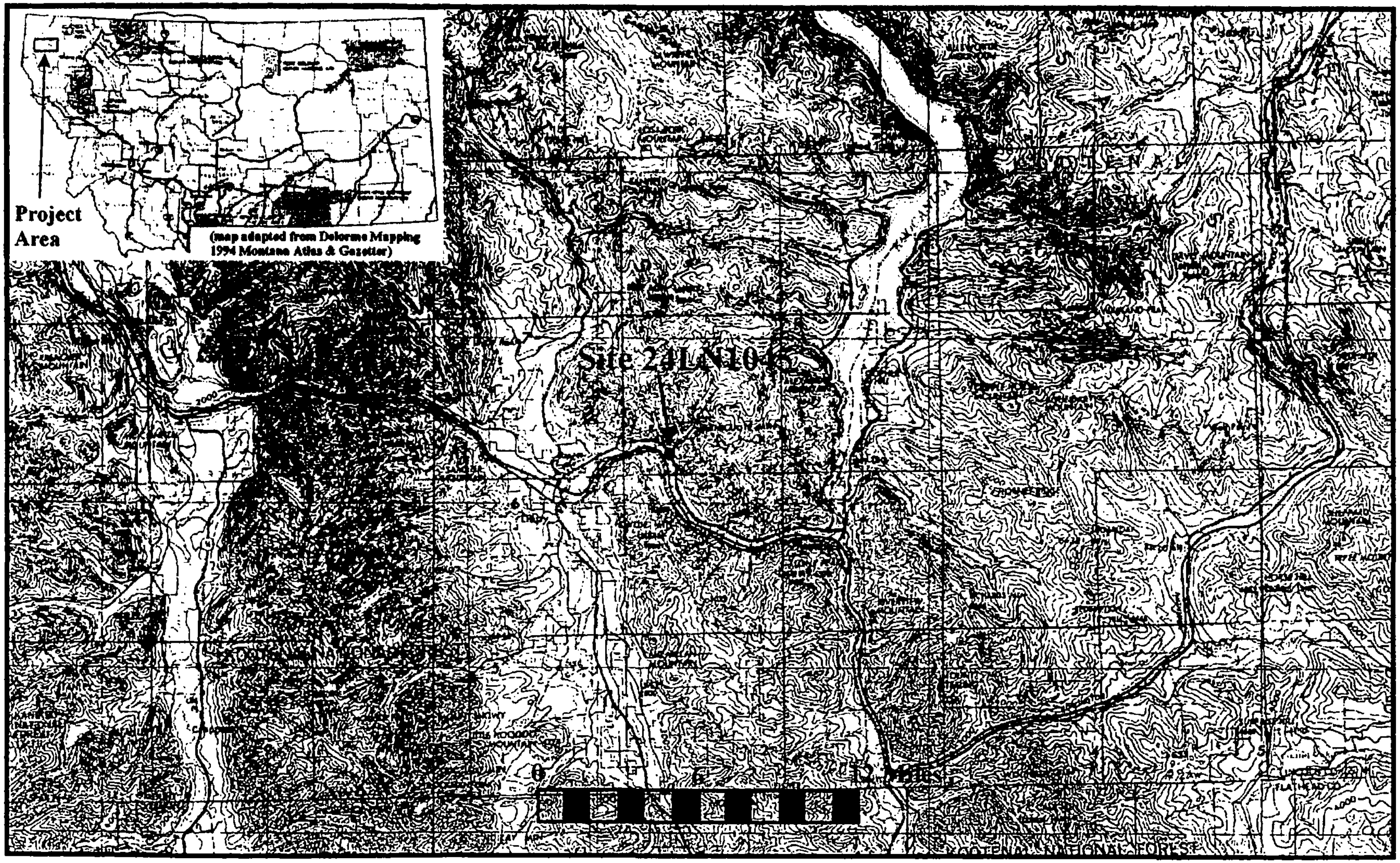

Figure 1: 250k scale Topographic map of site 24LN1045 project area.

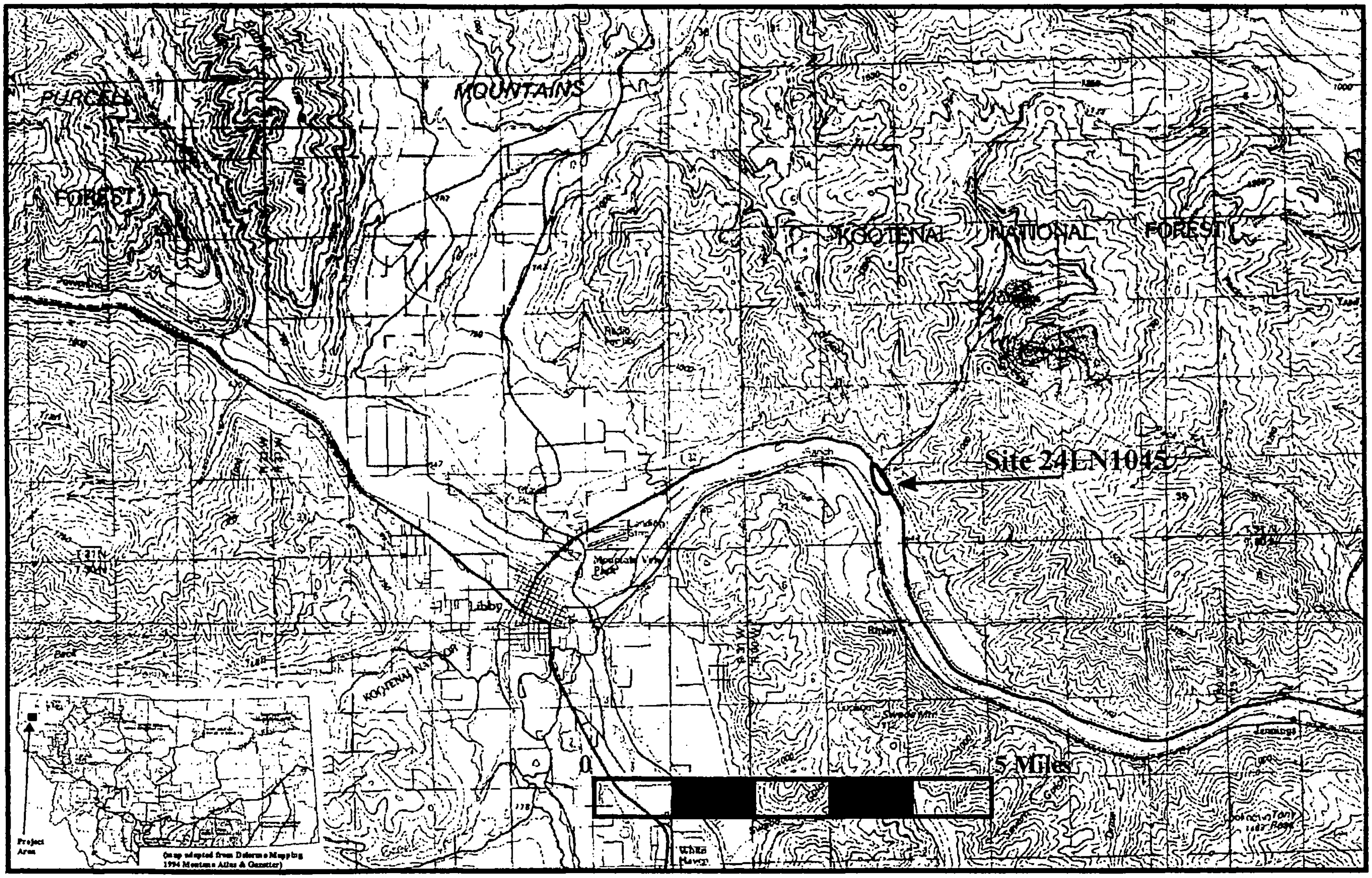

Figure 2: 100k scale Topographic map of site 24LN1045 project area.

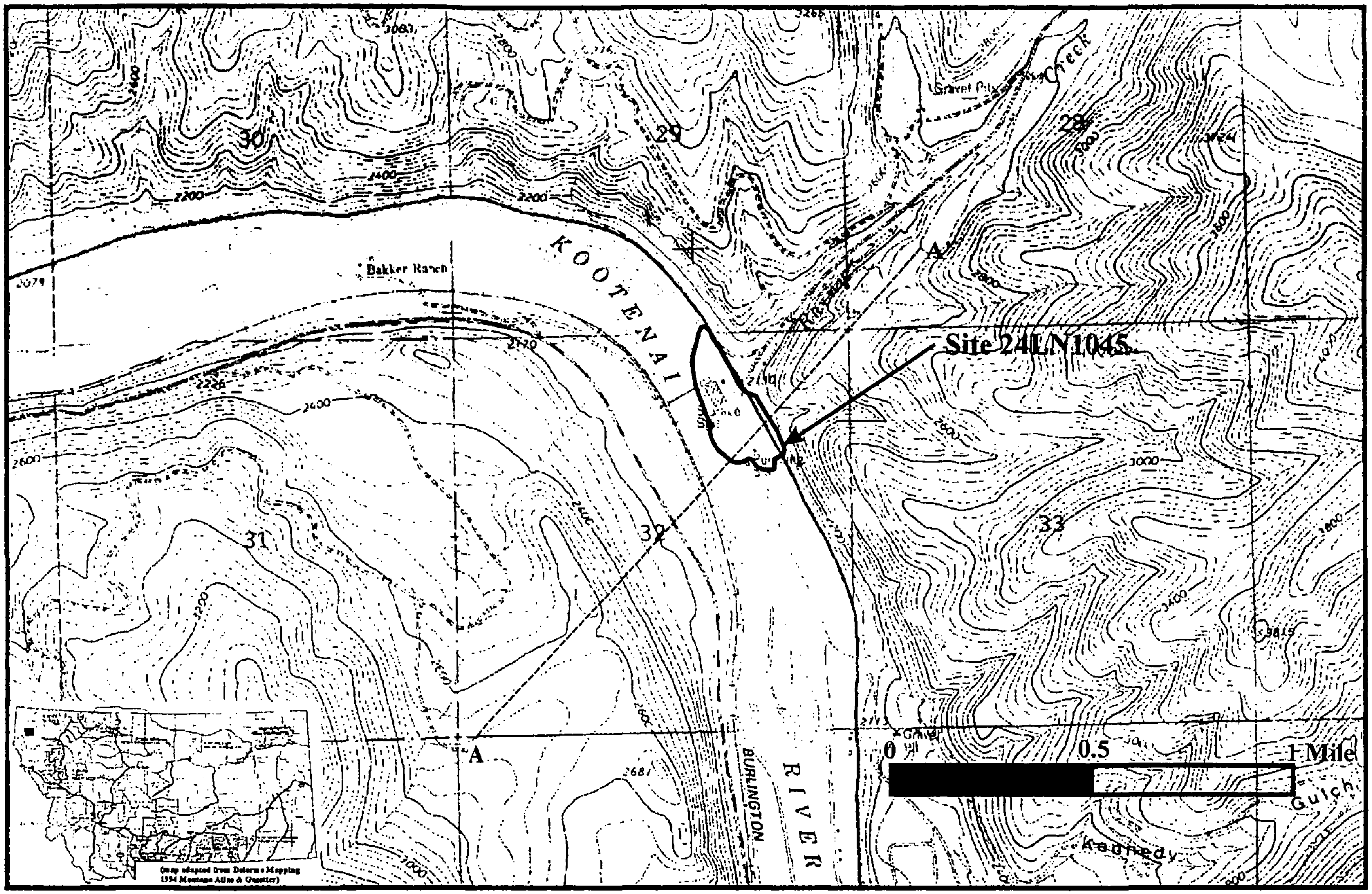

Figure 3: Vermiculite Mountain Quadrangle, Lincoln County-Montana, USGS 7.5' Topographic with site 24LN1045.

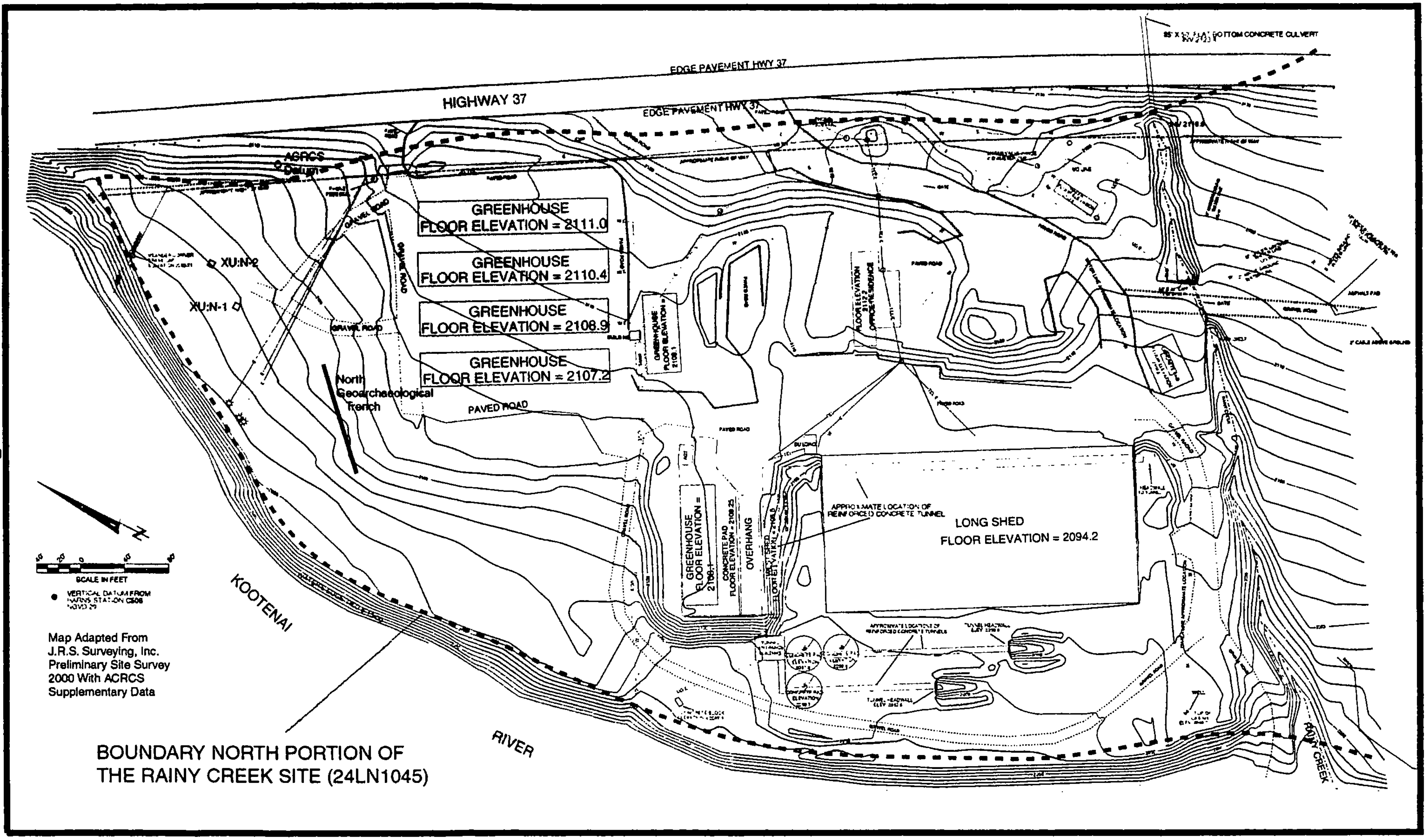

Figure 4: Map of Rainy Creek alluvial fan and north area, site 24LN1045.

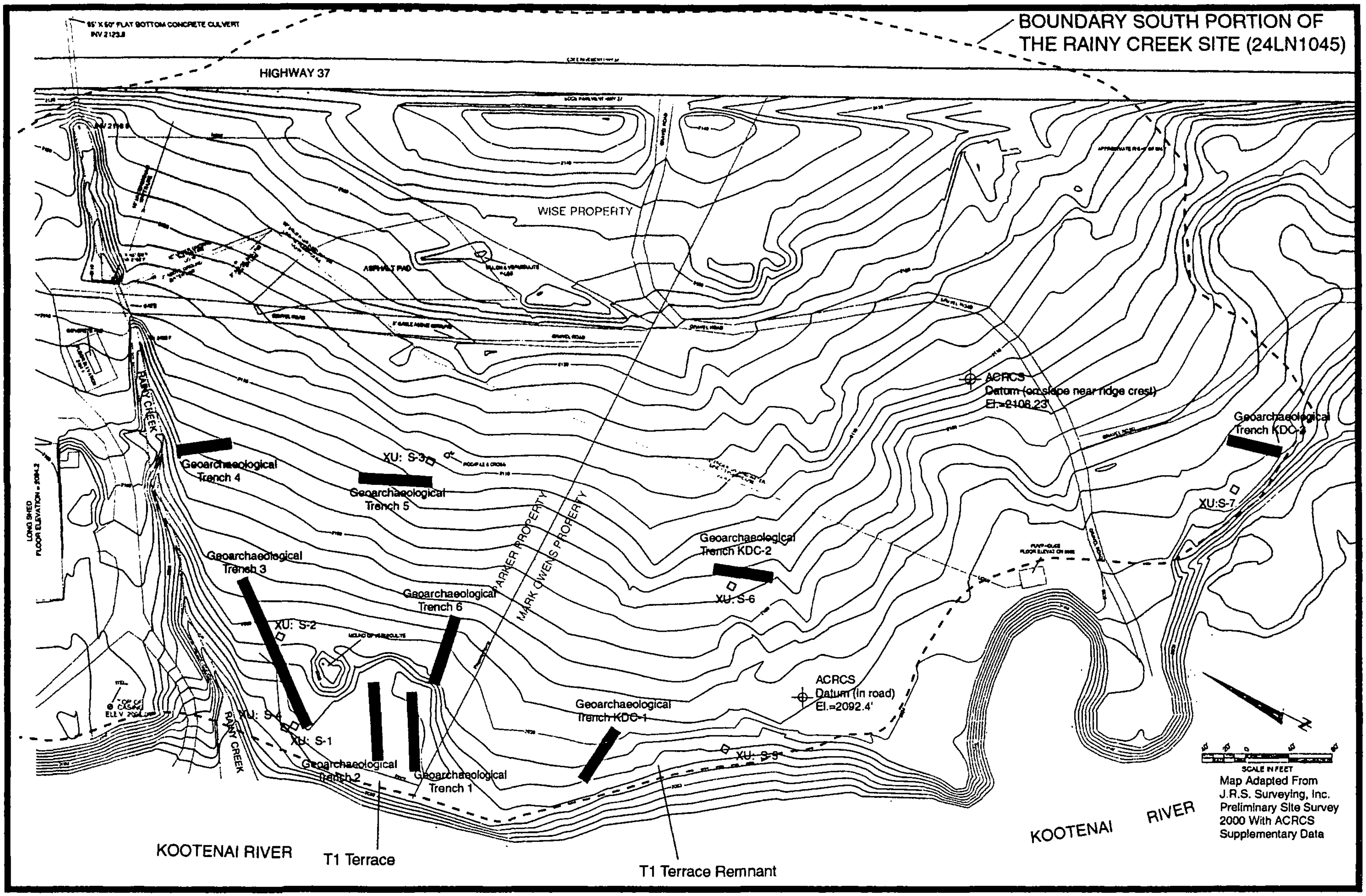

Figure 5: Map of Rainy Creek alluvial fan and south area, site 24LN1045.

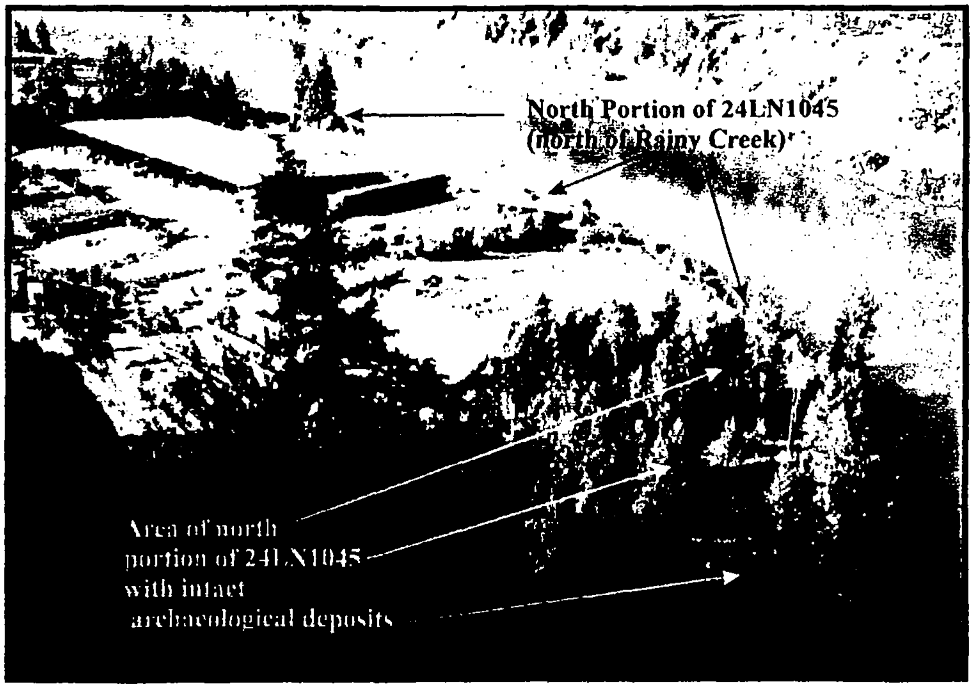

Figure 6: View south-southwest of north portion of 24LN1045.

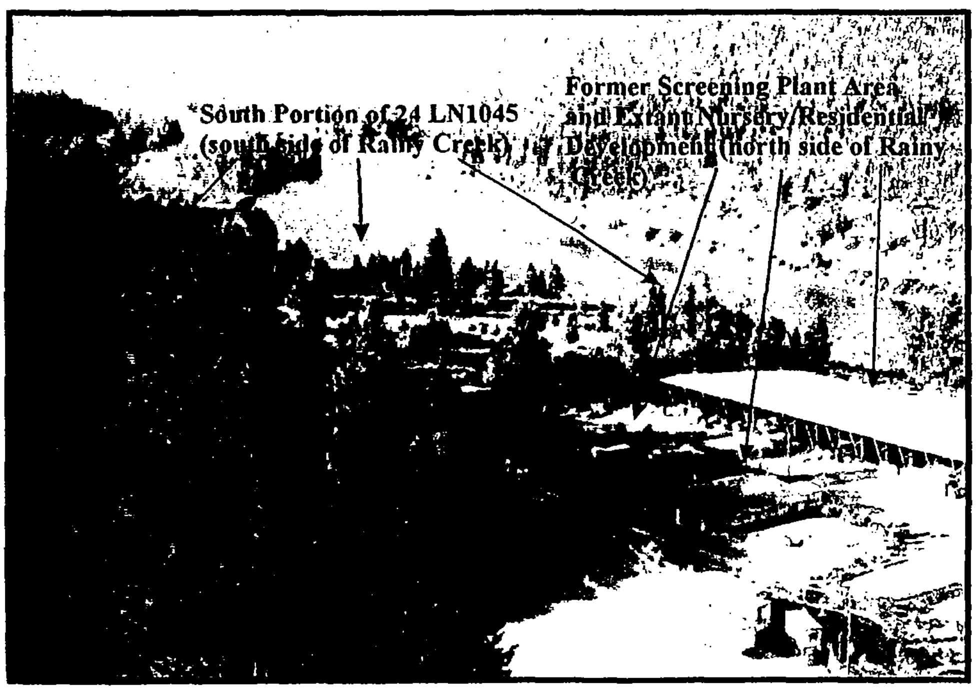

Figure 7: View south of south portion of 24LN1045.

Scope of Work

As the primary contractor for the project, CDM subcontracted with Aaberg Cultural Resource Consulting Service (ACRCS) to provide technical expertise in the area of legal responsibilities of the EPA, and their contractor CDM, with respect to cultural resource laws as they relate to archaeological site 24LN1045. More specifically, the statement of work attached to the CDM - ACRCS subcontract required: 1) review of relevant site (24LN1045) information; 2) conduct site visit if necessary; 3) prepare an evaluation of findings, list and description of applicable Federal and State of Montana regulations and statutes, draft recommendations for archaeological and cultural mitigation activities (plan for recovery of significant information) to be performed on archaeological site 24LN1045 in conjunction with the asbestos removal action; provide a draft recommendations report that would include anticipated work plan and a schedule of estimated cost of implementing the draft archaeological mitigation recommendations; 4) respond to review comments and prepare final recommendations for EPA submittal to the Montana Historic Preservation Office.

A report discussing these items was subsequently prepared and submitted to CDM, the EPA, the Montana State Historic Preservation Office, and the Salish-Kootenai Tribal Historic Preservation Office (Aaberg 2000). After comments were received from the Montana State Historic Preservation Office, the EPA, through their contractor CDM, entered into a subcontract with ACRCS to carry out site mitigation, excavation, and recovery of significant information.

24LN1045 REVIEW

by
Stephen A. Aaberg

History of Discovery

Although archaeological surveys and investigations along the Kootenai River between Libby, Montana and the Canada-United States border began as early as 1950 (Shiner) and continued through the 1960s and early 1970s (Taylor 1968, 1969, 1973), archaeological site 24LN1045 was not discovered until 1975 (Munsell 1975). Impetus for many of the early archaeological investigations of this stretch of the Kootenai River came from plans to construct a dam on the river between Libby and the Canada border. This dam, subsequently named Libby Dam, was completed in 1975.

Cultural resource survey along the Kootenai River below Libby Dam continued as plans were put forth to construct a reregulating dam (plans for constructing this dam were subsequently dropped when concerns over environmental issues led to litigation). Anticipating potential impacts to any cultural resources in the construction zone for the proposed reregulating dam and in the zone of pool level fluctuation, the United States Army Corps of Engineers-Seattle District (USACE-SD) initiated cultural resource survey between an area beginning about 7.5 miles upstream from Libby and ending just below Libby Dam. Much of the site identification phase of this survey was carried out by USACE-SD archaeologists including David Munsell. It was Munsell who in 1975 first discovered and recorded 24LN1045, to which he assigned the name

Rainy Creek Site. Archaeological investigations within what came to be known as the Libby Additional Units and Regulating Dam (LAURD) project area continued through the late 1970s and 1980s. Beginning in 1977 and continuing through 1979 the University of Idaho was contracted by the USACE-SD to continue archaeological survey, evaluate archaeological sites, and develop a cultural resource management plan for the LAURD project area (Bies, Rice and Sprague n.d.; Choquette n.d.; Choquette and Rice 1977; Choquette, Rice and Sprague 1978; Rice 1979).

Archaeological investigations up to 1978 identified 64 prehistoric and historic cultural resource sites in the LAURD project area (Roll and Smith 1982). The unusually high concentration of cultural resource sites, many judged individually as significant, in the approximately 7.5 mile long LAURD project area corridor along both sides of the Kootenai River led the USACE-SD to recommend that the entire project area be considered an archaeological district. In 1978, the USACE-SD formally defined the Libby-Jennings Archaeological District (including sites within the LAURD project area and some just outside the project area) and recommended that this district was eligible for inclusion in the National Register of Historic Places (NRHP). Federal regulations define an archaeological district as a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development (National Register Bulletin 36-1993; National Register Bulletin 15 - 1991 p. 5). The Rainy Creek Site (24LN1045) was included within the boundaries of the Libby-Jennings Archaeological District. Although the district was recommended as eligible for listing in the National Register of Historic Places (NRHP), as of December 1998 the Libby-Jennings Archaeological District and its constituent sites had not been formally nominated to the NRHP (Montana SHPO-MHS 1998).

Although the Rainy Creek Site was included in the Libby-Jennings Archaeological District, it was not discussed in the LAURD Cultural Resource Management Plan (Roll and Smith 1982). Since 24LN1045 lay over one mile downstream from the proposed site of the Libby reregulating dam, it was likely felt that the site was not in an area of primary effect associated with construction of, and operation of (pool fluctuation zone) the reregulating dam. In any case, 24LN1045 was not tested, excavated, or otherwise investigated during the LAURD cultural resource project begun by the University of Idaho in 1977 and continued by Montana State University in 1979 (Roll and Smith 1982; Roll 1982).

Investigative and Evaluative History

Upon discovery in 1975 (Munsell) the Rainy Creek Site was described as a "prehistoric habitation (open camp); possibly David Thompson's Kootenay house". The site was further described as consisting "of an open camp, midden deposit, on a sloping terrace of the Kootenai River upstream of the intersection of Rainy Creek with the Kootenai River" (Munsell 1975). Buried cultural materials were observed and Munsell stated, "The soil matrix is a brown, sandy silt, ca 2M in depth. The site is built on an alluvial fan created by Rainy Creek and includes numerous angular and rounded rocks, well sorted. The cultural deposit varies from 20cm on the easterly edge to in excess of 1M near the river. Extensive organic staining is evident". Cultural material observed at the site included "abundant organic staining, fire broken rocks, numerous bone fragments, cobble choppers, and cryptocrystalline and obsidian chipping debris" (Munsell

1975). At the time of discovery in 1975, the Rainy Creek Site occurred on private land, according to Munsell, owned by the "Zonolite Corporation". The Munsell site form describes the site condition as exhibiting "extensive surface modification in the form of recent historic house, garden and orchard development, borrow activities, and filling/disposal of vermiculite dust". Munsell recommended that 24LN1045 "should be extensively tested because of its high concentration of prehistoric materials and its potential to provide information regarding the early Kootenay house".

From 1975 until the fall of 1993, the Rainy Creek Site was not re-examined or further documented by any investigators. In 1993, the Montana Department of Transportation (MDT) began planning improvements along a segment of Montana State Highway 37 extending from Libby upstream along the Kootenai River for about eight miles. Highway 37 branches off U.S. Highway 2 at Libby and runs along the north side of the Kootenai River to just below Libby Dam where it crosses the river and passes along the east side of Lake Koocanusa (Libby Dam reservoir) before joining U.S. Highway 93 not far south of the Canada border.

The MDT contracted with ACRCS to carry out a Class III cultural resource inventory of the eight mile long Highway 37 project corridor. Although the 1993 proposed improvements to Highway 37 were minor, they had the potential to disturb or destroy sites within 50' of the road shoulders (Griffin and Aaberg 1994). The primary objectives of the 1993 ACRCS Class III survey were to identify and record any new cultural resource sites within the Highway 37 project corridor and to reinvestigate and evaluate portions of 24LN1045 that were found to occur within or very close to the MDT project area.

The Griffin and Aaberg (1994) report describes previous archaeological investigations in the area generally along the Kootenai River between Libby and the end of the Highway 37 project corridor near Lowry Gulch. In addition to 24LN1045, three previously recorded sites (24LN1036, 24LN1130 and 24LN1135) were found to occur on the north side of the Kootenai River within or very near the MDT project corridor. Two sites (24LN1036 and 24LN1130) were found to have been destroyed or severely damaged by construction of a haul bridge and road associated with the early phases of planning and construction of the since-canceled Libby reregulating dam. Site 24LN1135 was found to occur outside the Highway 37 right-of-way in an area which would not be affected by proposed highway construction. The only new cultural resource discovered during the 1993 survey was a remnant of a historic road, which had been disturbed and bisected by original construction of Highway 37.

The original sketch map drawn by Munsell in 1975 showed the boundaries of 24LN1045 restricted to the west side of Highway 37 and not extending to within the highway right-of-way. During pedestrian survey of the MDT highway right-of-way in 1993, a single basalt flake was found in the Highway 37 east road cut in an area not included in the original 1975 site boundaries. Because the Rainy Creek Site had never been tested or evaluated, the decision was made by the MDT and ACRCS to test areas within the Highway 37 project area to determine if the site extended to the highway. Since some construction disturbance was anticipated in the highway project corridor archaeological testing of the site also required that a determination of significance or NRHP eligibility be made.

Eight 50cm x 50cm test units were excavated during the 1993 Highway 37 project (Griffin and Aaberg 1994:26-27). Four of these subsurface test units (units 1-4) were located in the Highway 37 right-of-way with two on either side of the highway. Four test units (5-8) were placed west of Highway 37 outside of the right-of-way. Of the eight test units excavated in 1993 only units 7 and 8 sampled areas within the original 1975 site boundaries (Munsell 1975; Griffin and Aaberg 1994:26-27).

Of the eight test units excavated in 1993, only units 1, 2, and 4 were completely sterile and did not yield archaeological materials (Griffin and Aaberg 1994:28). Griffin and Aaberg (1994:28) summarized test unit yields by stating, "Of the units located outside the right-of-way, one (Unit 5) produced only three fragments of bone, from a single level. The most productive units were those located farthest west (Units 6-8). In general the horizontal density of cultural material, as represented by yield of test units, increases from east to west". The yield of all categories of archaeological materials recovered in 1993 (bone, fire-broken or heat-altered rock, and chipped stone artifacts) was greatest in Units 6-8. The four formal tools, including two fragmentary projectile points, were recovered from Units 7 and 8, the most westward of all 1993 test units and the only units placed within the 1975 site boundaries.

As a result of the 1993 investigations of 24LN1045, site boundaries were expanded northeasterly and were redrawn to include the west highway right-of-way and a small portion of the east right-of-way.

The absolute age(s) of prehistoric occupations at 24LN1045 had not been determined during any of the earlier investigation of the site. Radiocarbon dating was not undertaken as a part of the 1993 investigations. However, two fragmentary projectile points were recovered during 1993 testing (Griffin and Aaberg 1994:40). A provisional cultural typology based on projectile points associated with radiocarbon dates and other cultural materials and characteristics was defined by Roll (1982) for the LAURD project area. One projectile point (Biface 1) recovered from Unit 1 at 24LN1045 was found to be similar in form to LAURD Type 1-A points (Roll and Smith 1982:I.13). As stated by Griffin and Aaberg (1994:40) Roll considers Type 1-A points to represent Yarnell Phase occupations dating to ca. A.D. 1000-1800. The second projectile point (Biface 3) found at the Rainy Creek Site in 1993 was too fragmentary to reliably associate with a particular time period although similarities were noted between this specimen and those illustrated by Roll (1982) as representative of the Warex (A.D. 500 to 1200) and Yarnell Phases.

Archaeological materials were found between about 5cm and 40cm below surface in 1993 but discrete cultural strata within that zone of artifact yield were not discernible (Griffin and Aaberg 1993: 28). In all 1993 test units, gross natural stratigraphy was apparent but buried soils (paleosols) were not. Soils in all units were very similar with a nearly identical sequence of a thin humic zone of dark brown organic sandy loam (Stratum I) extending from surface to about 4cm below surface. Stratum I was underlain by Stratum II, a medium brown sandy loam with unsorted alluvial gravel and rock, from 4cm to 25cm below surface. Stratum III, below Stratum II, was a tan-brown or orange brown fine sandy loam with unsorted alluvial gravel and rock. Stratum II in all units generally yielded the greatest quantities of cultural material. Root penetration and rodent burrowing was noted in most units and disturbance of some cultural deposits by these agents was considered likely (Griffin and Aaberg 1994:29).

Other disturbances to the surface of 24LN1045 were also noted in 1993. Munsell (1975) had noted disturbance to the site through construction of a house and disposal of vermiculite dust. In 1993, the land upon which the Rainy Creek Site occurs was still owned by W.R. Grace however vermiculite processing and screening had ceased and a house no longer remained on the property. Just two months before the 1993 archaeological investigations of 24LN1045, W.R. Grace had undertaken reclamation of the vermiculite dust disposal areas within the boundaries of the site (Griffin and Aaberg 1994:25). Griffin and Aaberg (1994:26) further noted that, "Along with vermiculite, the topsoil was removed to an unknown depth, and the surface was recontoured..........Reclamation was concentrated in the eastern and southern portions of the site. Most of the rest of the site, along with "islands" in the southeastern part, were left intact". It was estimated that W.R. Grace reclamation activities affected about 20,300 square meters, or about 30 percent of the site. The site was originally estimated to cover about 45,000 square meters (Munsell 1975) but with the discoveries made in 1993 and expansion of boundaries, the site area was estimated at about 70,000 square meters.

Site 24LN1045 was evaluated as an archaeological site in 1993. Although Criterion D was not specifically quoted as the determinant of significance, it is obvious the investigators were using the general guidelines of archaeological significance under Criterion D (see below). In the concluding section (Griffin and Aaberg 1994:43-46) of the report detailing evaluation of the Rainy Creek Site the investigators state:

> *Although portions of 24LN1045 have been exposed to substantial surface and subsurface disturbances related to vermiculite processing and residential developments, the site retains areas of intact cultural deposits. These intact deposits include artifacts diagnostic of cultural period as well as a variety of other archaeological materials.*
>
> *Discernible features were not located during excavation, but the presence of FBR and the abundance of burnt bone demonstrate the site has the potential of containing features, possibly with dateable charcoal and/or other organics. The presence of numerous burned roots form forest fires could complicate the collection of radiocarbon dates. The lack of stratification in the deposits and the affects of bioturbation also complicate the process of determining context. Nevertheless, the potential for determining context remains in the form of bone, charcoal, and diagnostic artifacts (projectile points).*
>
> *Two square meters were excavated into the site, within and just outside the Highway 37 right-of-way. A total of 15 lithic artifacts were recovered from the eight 50cm square test units for an overall yield of 7.5 chipped stone artifacts per square meter. Bone yields were higher although most of the bone was fragmentary [the bone referred to in the conclusion was earlier in the Griffin and Aaberg report identified as non-human, medium-size ungulate bone possibly from*

deer]. Bone fragments numbering 163 and weighing 54.72 grams were found in tests for a yield of 81.5 fragments (27.36 grams) per square meter.

Buried sites with potential context are uncommon in northwestern Montana. As such a site, 24LN1045 could contribute to understanding of local and regional prehistory. Numerous questions on local subsistence adaptations and unique cultural systems remain unanswered for much of western Montana, west of the Continental Divide. With moderate material cultural densities and the possibility of preserved context, good research potential is indicated by the site. Therefore 24LN1045 is recommended as eligible for listing in the National Register of Historic Places.

In 1978, as a part of the Libby-Jennings Archaeological District, the Rainy Creek Site had been recommended as eligible for listing in the NRHP. In 1993, as an individual site, 24LN1045 was recommended as eligible for inclusion in the NRHP.

Munsell (1975) in the original site form for 24LN1045 suggested the site could possibly be the location of David Thompson's Kootenay House. Griffin and Aaberg (1994:16-17) present a brief summary of David Thompson's activities in what is now the state of Montana. Thompson was a Welshman who migrated to Canada in 1784 and began working for the Hudson's Bay Company and later the North West Company (Malone et. al. 1991). Thompson was a part of British interests push into interior western North America and by 1807 or 1808 Thompson and the North West Company entered Montana and began establishing trading posts or houses. The first North West Company trading post was named Kootenay or Kootenai House (Malone et. al. 1991; Toole 1959). The exact location of Kootenay House is not known with certainty. Toole (1959:45) states that Thompson built "Kootenae House" at the foot of Lake Windermere. Toole goes on to say, "From Kootenae House, Thompson dispatched Finan McDonald down the Kootenai River, where he set up a post in the neighborhood of present-day Libby, Montana" (Toole 1959:45). These statements suggest Kootenai House was upstream from Libby in the vicinity of Lake Windermere which is on the Kootenai River in British Columbia well north of the U.S. border. Malone et al. (1991:44) state that Thompson established *Kootenai Post* near present-day Libby, Montana but that three years later the post was moved farther up the Kootenai River near the mouth of the Fisher River. Part of the problem with reference to Kootenay House is the fact that apparently Kootenai Post or Fort Kootenai was an entirely different facility than Kootenay House. There seems to be general agreement that Kootenay House was established at the headwaters of the Columbia which are in British Columbia whether referring to the actual upper end of the Columbia River itself or to the upper Kootenai River. In any case, Griffin and Aaberg (1994:25) state that posts of any sort have never been documented as occurring at the mouth of Rainy Creek. However, in a recent (July 2000) conversation with ACRCS Mark White stated that he had some early maps and information that indicates a very short term trading post may have been located at the mouth of Rainy Creek (7/00 Mark White, personal communication).

After conferring with Kootenai Forest-Libby District archaeologist Mark White, Griffin and Aaberg speculate that Munsell may have been confused by a historic name associated with Rainy Creek. According to White, a cabin was constructed at the mouth of Rainy Creek by Ben

Thomas who prospected on Rainy Creek and entertained travelers who passed through the Kootenai valley. Local informants suggest that it was Thomas who planted the apple orchard still present within the boundaries of 24LN1045 before asbestos remediation began in the summer of 2000 (subsequent soil stripping entirely obliterated the old orchard). The Thomas cabin is labeled and depicted on some early historic maps of the area including the 1899 General Land Office map of the township and range and on some 1903 timber cruise maps. Griffin and Aaberg further cite Mark White as indicating that some sources place the Ben Thomas cabin on the south side of Rainy Creek within the boundaries of 24LN1045 while others place it on the north side of Rainy Creek in the location of the W.R Grace screening plant.

The end result of the discussion of Kootenay House and the Ben Thomas cabin was that 24LN1045 was recommended as eligible for inclusion in the NRHP solely on its value as a prehistoric archaeological site. Any evidence of the Ben Thomas cabin had long since disappeared and there is strong evidence indicating that Kootenay House was never located anywhere near Rainy Creek. More detailed information on the local history of Rainy Creek and the possibility that there may have been fur trade posts in the area is presented in a later section of this report (Culture History - History).

2000 Site Survey

During research and preparation of the data recovery plan in 2000, records documenting surface survey or any other archaeological investigation of the north side of Rainy Creek (where buildings and structures associated with the W.R. Grace screening plant occurred) could not be located. Although the locality occurred generally within the USACE-SD LAURD project area, it could not be determined if the property had ever been inspected by archaeologists. Federal law requires that attempts be made to locate cultural resources within project boundaries of any federal undertaking where the landscape will be altered. Because previous archaeological survey of the north side of Rainy Creek could not be documented, and because this property occurs in close proximity to the 1975 and 1993 boundaries of 24LN1045, the EPA through its contractor CDM, requested that ACRCS carry out a surficial examination of the north side of Rainy Creek to determine if archaeological materials occur in that area. Through a contract amendment, ACRCS agreed to carry out a surficial survey of Operable Unit 2 including the former location of the W.R. Grace screening facility. Principal investigator Stephen Aaberg, of ACRCS, examined the property on the morning of July 26, 2000.

The EPA, through its contractors and subcontractors, had already begun preliminary fieldwork and analyses associated with remediation of the old vermiculite processing locality prior to the July of 2000 archaeological survey. The extreme threat to public health represented by the asbestos contaminated property required immediate action by the EPA. The pre-remediation soil testing included small scale probing as well as larger pits and trenches. Erosion control was a priority on the property and shallow trenches adjacent to Rainy Creek and the Kootenai River (north of Rainy Creek) had been excavated and lined with straw bales. The 2000 archaeological survey carried out by ACRCS was restricted to surficial observations and observations of pits, trenches, erosional exposures, and the river bank. The entire remediation property located on the north side of Rainy Creek was inspected by Aaberg. Portions of

24LN1045 (as identified in 1975 and 1993) on the south side of Rainy Creek were also reinvestigated by Aaberg in July of 2000.

Upon examination of the north side of Rainy Creek in 2000, it was obvious that more development of the property had occurred since it was viewed in 1993 (Figures 4 and 6). Nursery and greenhouse facilities, as well as a residence, had been constructed by the current property owners who acquired the land from W.R. Grace. Additional roads had also been constructed. The south side of Rainy Creek (Figures 5 and 7) on the other hand did not appear to have undergone substantial disturbance or development since 1993 although private landowners on the south end of the property hope to construct a residential subdivision when remediation is complete.

Examination of remediation-related pits and trenches disclosed that cutting and filling up to two meters in depth had occurred in portions of the north side property. Examination of the pits and the Kootenai River bank indicated that the landform on the north side of Rainy Creek is composed primarily of alluvial sands and gravels deposited (alluvial fan) principally by Rainy Creek. Observation of the various subsurface exposures indicated that about 75% of the landform on the north side of the creek had undergone substantial development-related disturbance to an unknown depth. The extreme north edge of the property appeared to have escaped substantial disturbance (Figure 6). It was in this area that archaeological materials were first noted. Numerous small fragments of burned and calcined bone, a few pieces of heat-altered rock, and five flakes (chert, chalcedony, and argillite) were observed in disturbed areas near power poles and guy wire anchors (Figures 4 and 6). One chert flake and several heat-altered rocks were also noted on the surface about 50 meters south-southwest of the power poles. Several fragments of burned and calcined bone and one unburned long bone fragment from a medium-size ungulate were noted *in situ* in the river bank adjacent to the power poles. These materials were apparent about 12-15cm below surface. Overturned sod adjacent to one of the power poles contained numerous burned and calcined bone fragments within the root zone and suggested that these archaeological materials likely lay at about the same depth as those observed in the river bank. One small calcined bone fragment and one chert flake were observed in a road cut near the mouth of Rainy Creek. These materials were not in place.

Archaeological materials of any sort were not evident in any of the remediation-related test pits or trenches. Nor were archaeological materials visible in the river bank (north side of Rainy Creek) below about 15cm. Neither natural soil nor cultural horizons were evident in deeper exposures of the alluvial fan deposits.

Based on the presence of numerous bone fragments and other archaeological materials near the north end of the property, the boundaries of 24LN1045 were expanded to include much of the alluvial fan on the north side of Rainy Creek (Figures 4 and 5). Although archaeological materials were extremely scant over much of the north side property, it was judged likely that the shallowly buried cultural deposits observed on the north edge once extended over much of the property. Extensive disturbance of the surface during construction and operation of the vermiculite plant, and later the private nursery and residence, likely obliterated much of the shallow cultural deposits. However, the archaeological materials observed near the north end of the site were seen as likely retaining context since Rainy Creek appears to have been in a down-cutting mode for some time and recent fan deposits were not apparent (Aaberg 2000).

Portions of the south side of Rainy Creek where the original boundaries (1975 and 1993) of 24LN1045 were delineated were also reinvestigated in 2000. As opposed to the north side of Rainy Creek, the landform on the south side includes Kootenai River overbank fines in areas marginal to the river as well as alluvial fan deposits in eastward portions. Although the south side of the creek had experienced some disturbance, investigation of the river bank indicate that portions of the site remained intact.

Numerous bone fragments and heat-altered rocks were noted in overbank sediments exposed in the river bank. These materials occurred within about the first meter below surface. Preliminary observations suggested that cultural materials occurred in at least two zones, one in the first 20-30cm below surface and one from 60-90cm below surface (Aaberg 2000). At some time in the past, a pit had been excavated adjacent to the river. This pit was then infilled with vermiculite to an unknown depth. Overburden removed from this pit when it was excavated lay adjacent to the pit. Examination of this overburden in 2000 revealed numerous fragments of both burned and unburned bone (dominated by medium-size ungulate). Numerous fragments of heat-altered rock were also visible in the overburden. Two argillite flakes, three chert flakes, and a quartzite flake were noted in and around the overburden pile and in the river bank adjacent to the pile. More bone and heat-altered rocks were observed in the river bank to the southeast of the vermiculite pit.

In 2000, surficial observations suggested that the richest (in terms of artifact or cultural material content) portion of 24LN1045 lay within the original 1975 boundaries of the site in areas marginal to the Kootenai River. Shallowly to deeply buried archaeological materials were indicated here.

The brief archaeological survey carried out in July of 2000 resulted in expansion of the boundaries of 24LN1045 to include the north side of Rainy Creek. This survey indicated that intact, shallowly buried cultural deposits were present on the extreme north end of the site (Figures 4 and 6). Although subsurface testing was not part of the 2000 investigations, observations of remediation-related pits and trenches suggested that much of the north side of the creek had been disturbed and that deeply buried cultural deposits with good context are unlikely to be present in the high-energy alluvial fan deposits. The shallowly buried archaeological deposits at the north edge of the site appeared to be intact and included dateable organics (bone) and lithic artifacts. This small undisturbed portion of the site north of Rainy Creek was recommended as contributing to the overall significance of 24LN1045 (Aaberg 2000). The 2000 survey also indicated that rich, undisturbed cultural deposits were present on the south side of Rainy Creek and were particularly evident in areas marginal to the Kootenai River (Figures 5 and 7).

LEGAL CONSIDERATIONS AND PROCESSES

by
Stephen A. Aaberg

Introduction

Cultural resources are tangible remains of past human activity within the landscape. Cultural resources are identified and defined as geographic units or "sites" where past human activity occurred and evidence of past use can be documented. Generally, any site of human activity older than 50 years can be considered to be a cultural resource. Cultural resources include both historic and prehistoric sites. Historic sites are distinguished from prehistoric sites by general age with historic sites associated with the era of written records for a particular area and prehistoric sites pre-dating written records for a particular area. Some sites which contain historic era artifacts (e.g. metal and glass items) but which date to a period before direct white or Euro-American contact with aboriginal or American Indian/Native American populations are termed protohistoric sites. Archaeological sites are included in the term cultural resources but most often define sites that are in ruins and whose histories must be interpreted. Archaeological sites can be both historic and prehistoric in general age.

Traditional cultural properties are defined as landforms, spiritual use locations, or economic use areas important to modern Native Americans in the expression and practice of traditional cultural values, spirituality, and religion. These traditional resources often have a long history of use, and are associated with beliefs, customs, and practices of modern communities. Oral histories documenting the roles of these resources in traditional cultural values have often been passed down through generations. These traditional resources play a continuing role in tribal identities and sense of community. Native American resources do not always display physical evidence of past human use since many activities of traditional cultural expression leave no observable impact on the environment. Some archaeological sites may be considered as traditional cultural properties particularly if they contain artifacts or objects, which can be defined as sacred or religious in nature.

Native American resources and religious practices are protected by a number of federal laws, including the 1978 American Indian Religious Freedom Act (AIRFA), the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), and the National Historic Preservation Act of 1966 (NHPA). Federal guidelines direct federal agencies to consult with contemporary Native American tribal representatives and traditionalists who may have concerns about federal actions that may affect religious practices or other traditional cultural uses.

Historic and prehistoric cultural resources are protected by federal laws including the Archaeological Resources Protection Act (ARPA) of 1979, the NHPA and various amendments and statutes, and the National Environmental Policy Act of 1969 (NEPA). In Montana, cultural resources on state land, or in areas affected by a proposed undertaking permitted or directed by the state, are protected by the Montana Environmental Protection Act (MEPA).

History of Cultural Resource Laws

The first law enacted to protect what have come to be known as cultural resources was the Antiquities Act of 1906. This law gave the federal government and federal officials the responsibility of protecting archaeological sites as public resources. Two subsequent federal acts were passed in part because of the failure of the 1906 Antiquities Act to adequately protect archaeological and historic sites. The first of these acts was the 1966 National Historic Preservation Act (NHPA) and the second was the 1979 Archaeological Resources Protection Act (ARPA).

The NHPA directed the Secretary of the Interior to expand and maintain a National Register of historic sites, districts, buildings, structures, and objects. The NHPA has become the principal legislation for implementing historic preservation particularly on Federal lands or on Federal undertakings (e.g. permitting, licensing, cost-sharing, loans for development). The National Register of Historic Places or National Register has become the official list of cultural resources determined, through a formal evaluation process, worthy of preservation because they are significant in American history, architecture, archaeology, engineering and culture (Montana SHPO-MHS 2000:2).

Another early law associated with the protection of cultural resources was the Historic Sites Act of 1935, which established a national policy for preserving historic resources for public use. This act gave the Secretary of the Interior "the power to make historic surveys, and to document, evaluate, acquire and preserve archaeological and historic sites across the country" (Montana SHPO-MHS 2000:1).

In 1947, the National Council for Historic Sites and Buildings was organized to include members of the American public as well as representatives of the National Park Service and others interested in historic preservation (Montana SHPO-MHS 2000). Organization of this council was followed in 1949 by the establishment of the National Trust for Historic Preservation which "was charged with facilitating public participation in historic preservation and was empowered to receive donations of sites, buildings and objects significant in American history as well as to administer gifts of money, securities and other property for carrying out a preservation program" (Montana SHPO-MHS 2000).

The 1966 NHPA established the Advisory Council on Historic Preservation (ACHP) as an independent Federal agency to advise the President and Congress on matters involving historic preservation. The ACHP was authorized to review and comment on all actions permitted by, licensed by, directed by, or undertaken by the Federal government that will have an effect on cultural resources. Subsequent amendments and to the NHPA and the issuance of statutes have continued through the 1990s. Eventually a system of State Historic Preservation Offices (SHPOs), headed by a State Historic Preservation Officer, was established with Federal assistance to aid in administering the many aspects of the NHPA on a local and state level. In Montana, the State Historic Preservation Office is part of the Montana Historical Society but SHPO responsibilities are focused toward the many angles of historic preservation encompassed by the NHPA.

The 1979 Archaeological Resources Protection Act (ARPA) established major criminal and civil penalties for violators of the 1906 Antiquities Act. Amendments made to ARPA in 1988 simplified prosecutions and required federal agencies to undertake archaeological surveys and to develop and expand public education programs related to archaeological resources.

Another law passed in 1990 has implications for some archaeological sites. This law, the Native American Graves Protection and Repatriation Act (NAGPRA), requires federal agencies and most museums in the United States to inventory Native American human remains, burial artifacts, sacred objects, and objects formerly owned communally by tribes. It also requires federal agencies to offer to return these items to Indian tribes that are clearly affiliated with them. If such remains and artifacts are discovered in archaeological sites, then elements of NAGPRA apply to investigations of, and administration of, such sites. Elements of AIRFA can apply to some archaeological sites too if sites or artifactual remains within them are associated with, or can be documented to have been associated with Native American religious practices.

Laws Applicable to the Libby Asbestos Project and 24LN1045

Operable Unit 2 and 24LN1045 occur on private land (Parker, Wise and Owen/KDC properties) adjacent to the Kootenai River. This location is either entirely within, or partially within, the boundaries of a number of Class III cultural resource inventory projects beginning in 1950 and continuing through 1994 (Shiner 1950; Taylor 1968, 1969, 1973; USACE-SD 1975; Munsell and Salo 1979; Roll and Smith 1982; Roll 1982; Bies et. al. n.d.; Rice 1979; Griffin and Aaberg 1994). Operable Unit 2, in the past, had been adequately surveyed to determine the presence or absence of historic or prehistoric archaeological sites. The United States Army Corps of Engineers - Seattle District (USACE-SD) carried out archaeological survey of the banks of the Kootenai River in the Libby Additional Units and Reregulating Dam Project Area, which encompassed Operable Unit 2 of the Libby Asbestos Project. It was during this USACE-SD survey in 1975 that 24LN1045 was first discovered and recorded (Munsell 1975). Although details on the systematics and areas covered by this USACE-SD survey were not available during preparation of discussions presented herein, it is presently assumed that all of Operable Unit 2 had been inspected for the presence of archaeological sites. Obligations under ARPA appear to have been met with respect to archaeological survey of Operable Unit 2. It is not known if Operable Unit 1 and the area of the vermiculite mine had been intensively surveyed to determine if cultural resources are present in potential impact areas. As the lead federal agency the EPA would be responsible under ARPA, as well as NHPA, to ensure that cultural resource considerations and investigations of Operable Unit 1 have occurred or will occur prior to land-disturbing activities.

Archaeological site 24LN1045 was first recorded in 1975. An unusually high concentration of archaeological sites along the Kootenai River between Libby and Libby Dam was defined as the Libby-Jennings Archaeological District by the USACE-SD and in 1978, this district was recommended as eligible for inclusion in the NRHP. As a constituent member of the Libby-Jennings Archaeological District, 24LN1045 was also considered eligible for NRHP listing in 1978 but was not individually evaluated for significance until 1993 (Griffin and Aaberg 1994) when it was recommended as eligible for listing in the NRHP. Proposed removal of asbestos-contaminated soil includes as yet unspecified areas within the boundaries of

24LN1045. Preliminary results of testing for contamination suggested that much of the site contained asbestos. The Libby Asbestos Project is being directed and coordinated by Region 8 of the EPA and is a federal undertaking. Therefore, federal laws, primarily NHPA, apply to the Libby Asbestos Project. A discussion of NHPA and its various sections and statutes applicable to the Libby Asbestos Project is presented below.

Section 106 Review

Federal regulations applicable to the process of complying with NHPA as it relates to the protection of historic sites or properties are covered in 36 CFR Part 800 of NHPA regulations. Part 800 of these regulations discusses Title 1- Section 106 of the NHPA. Compliance with Federal cultural resource laws has come to be known as "the 106 process" or "Section 106 process". It is Section 106 which is most applicable to consideration of 24LN1045 within the scope of the proposed Screening Plant Removal Action Work Plan - Libby, Montana Asbestos Emergency Response Project. Relevant portions of Part 800 of the NHPA regulations which detail the Section 106 process are presented below. Much of that presented below is excerpted directly from the *Section 106 Users Guide,* the *106 Regulations Summary,* the *106 Regulations Flow Chart Explanatory Material,* the *106 Recommended Approach for Consultation on Recovery of Significant Information from Archeological Sites,* the *Indian Tribes and the Section 106 Review Process, Section 106 Major Changes,* and *The National Historic Preservation Act of 1966, as amended* as they were presented on the Advisory Council on Historic Preservation web site at **http://www.achp.gov** on June 26, 2000. In the language of NHPA and its attendant regulations an agency or Federal agency or Federal Official would be, in the case of the Libby Asbestos Project, the EPA.

Sec. 800.1(a) - Purposes of the Section 106 Process

Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation (Council) a reasonable opportunity to comment on such undertakings. The goal of consultation is to identify historic properties potentially affected by the undertaking, assess its effects, and seek ways to avoid, minimize or mitigate any adverse effects on historic properties. Routine decisions regarding the Section 106 process will no longer be reviewed by the Council as long as there is agreement between the Federal agency responsible for compliance and the State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Officer (THPO). The Council may enter the Section 106 process when an undertaking 1) has substantial impacts on important historic properties; 2) presents important questions of policy or interpretation; 3) has the potential for presenting procedural problems; or 4) presents issues of concern to Indian tribes or Native Hawaiian organizations.

The EPA accepted their role as the Federal agency responsible for ensuring Section 106 compliance. The EPA, through their contractor CDM, began the Section 106 process and made preliminary contact with the Montana SHPO in the Spring of 2000. Section 106 regulations encourage early compliance to allow time for all considerations and interactions. The emergency nature of the Libby Asbestos Project presented some time constraints and attempts were made to accelerate the 106 process.

Sec. 800.3(a) - Establish Undertaking

If an Agency Official has determined that the undertaking (Libby Asbestos Project) does have the potential to cause effects on historic properties, the agency proceeds to identify properties that might be affected. In this case, the EPA recognized the presence of 24LN1045 within the Libby Asbestos Project Area and began the process of considering the affects of their undertaking through their contractor CDM.

Sec. 800.3c - Identify the Appropriate SHPO and/or THPO

The Federal agency (in this case the EPA) has the responsibility to properly identify the appropriate SHPO and/or THPO (Tribal Historic Preservation Office) that must be consulted. Operable Unit 2 of the Libby Asbestos Project occurs on private land well outside the boundaries of any Indian Reservation. The Montana SHPO is generally the appropriate Section 106 advisory body for cultural resources located on non-tribal lands off any reservation. However, Section 101(d)(6)(b) of the NHPA requires consultation with any Indian tribe that attaches religious and cultural significance to historic properties that may be affected by an undertaking regardless of location. Such Indian tribe is a consulting party and consultation can be facilitated through a THPO, tribal cultural committee, tribal council, or any other groups or individuals.

The Confederated Salish-Kootenai Tribes of the Flathead Reservation are Native American groups most proximal to the Libby Asbestos Project area and Salish-Kootenai peoples have ancestral ties to the project area.

Sec. 800.3(e) - Plan to Involve the Public

The EPA must decide early how and when to involve the public in the Section 106 process. A formal plan is not required, although that may be appropriate depending upon the scale of the undertaking and the magnitude of its effects on 24LN1045. The EPA held a number of public meetings in the Libby area before beginning remediation. Reportedly, some members of the public commented on presence of archaeological site 24LN1045. Among those members of the public who commented on the archaeological site were Mel and Lerah Parker who own the land upon which about 50% of the site occurs. Kootenai Forest archaeologist Mark White, commenting as a member of the public, also brought up concerns over the Rainy Creek Site.

Sec. 800.3(f) - Identify Other Consulting Parties

The EPA, at an early stage of the Section 106 process, is required to consult with the SHPO to identify those organizations and individuals that will have the right to be consulting parties under the terms of the regulations. These may include local governments, Indian tribes, and applicants for Federal assistance or permits. Others may request to be consulting parties, but the decision is ultimately up to the Agency Official (EPA). Although both the Montana SHPO and the Salish-Kootenai THPO were contacted prior to the involvement of ACRCS in the Section 106 process, the nature of those contacts are not known to ACRCS.

Sec. 800.3(g) - Expediting Consultation

An Agency Official (EPA) can combine individual steps in the Section 106 process with the consent of the SHPO. Doing so must protect the opportunity of the public and consulting parties to participate fully in the Section 106 process. Because of the emergency nature of the

Libby Asbestos Project, a formal request was made by the EPA to the Montana SHPO to expedite the 106 process. On Thursday August 3, 2000, a meeting was held at the Montana State Historic Preservation Office in Helena, Montana. The meeting was attended by Stan Wilmoth of the Montana SHPO, Paul Peronard of the EPA, Robert Alexander of CDM Federal Programs Corporation (contractor for the EPA), John Constan of the Montana Department of Environmental Quality, and Stephen Aaberg of Aaberg Cultural Resource Consulting Service. The proposal for recovery of significant information from 24LN1045 was reviewed and discussed at this meeting. Stan Wilmoth agreed in principal with the recovery plan but recommended that the Advisory Council and the Salish-Kootenai Tribal Historic Preservation Council be contacted immediately since their review and comments are necessary in the 106 process.

A letter report detailing the proceedings of the August 3 meeting at the Montana SHPO office in Helena was prepared by ACRCS for CDM. That letter appears below.

August 4, 2000

Peter Borowiec
CDM Federal Programs Corporation
One Cambridge Place
50 Hampshire Street
Cambridge, Massachusetts 02139

RE: Summary of meeting with Montana State Historic Preservation Office
Dear Peter:

At 2:00 PM on August 3, 2000, a meeting with the Montana State Historic Preservation Office was held for the purpose of discussing archaeological mitigation and data recovery, and the Section 106 process, for site 24LN1045 which occupies Operable Unit 2 (vermiculite screening plant site) of the Libby Asbestos Emergency Response project area. In attendance at this meeting was Stan Wilmoth (State Archaeologist), representing the Montana State Historic Preservation Office, Paul Peronard, representing Region 8 of the Environmental Protection Agency, Robert Alexander, representing CDM, John Constan, representing the Montana Department of Environmental Quality, and Stephen A. Aaberg, archaeological subcontractor for CDM. The meeting was held in the conference room of the Montana State Historic Preservation Office (1410 Eighth Avenue, Helena, Montana).

*After introductions, a copy of the most recent draft (August 2000) of the report, **The Rainy Creek Site (24LN1045) Data and Significant Information Recovery Plan and Section 106 Process Review as Part of the Screening Plant Removal Action Work Plan Libby, Montana Asbestos Emergency Response Project, U.S. Environmental Protection Agency Region 8**, by Stephen Aaberg, was distributed to all attending the meeting. Robert Alexander distributed copies of the detailed, AutoCad contour map of the project location to Stephen Aaberg and Stan Wilmoth.*

After a quick review of the map and report Stan Wilmoth asked that Paul Peronard summarize the EPA plan for remediation at the screening plant locality. Paul described the plan and included a description of likely impact to the archaeological site (depth of soil stripping, likely areas of deep soil stripping, etc.). Stan then requested that Aaberg present a review of archaeological findings and the proposed data recovery/mitigation plan for 24LN1045 and how they relate to proposed remediation.

Stan Wilmoth had a few questions on data recovery and remediation. Those questions included what provisions the EPA has for site protection in the event that deeply buried cultural deposits, below the zone of soil stripping, were discovered. Paul explained that the EPA may bring the landform up to its present grade after contaminated soil was removed but wasn't absolutely certain about the degree of reclamation/recontouring. Paul did state that the surface of the property would be revegetated and would be stabilized so the archaeological site would not be exposed to erosion. Paul also mentioned that since 24LN1045 occurs on private land there were limitations to EPA assurances of long-term site protection once the project is completed.

Stan also suggested that the archaeological data recovery proposal should include an additional statement in support of deep, back-hoe trenching, to augment archaeological hand excavations. Stan agreed that deep, mechanical testing would be valuable but felt the proposal should specifically state that after such testing far more information on the prehistoric occupations and past environments of the area would be known (which would not be the case if such testing were not carried out). As a follow-up to that discussion, Dr. Wilmoth also suggested that more details on the amount of backhoe trenching should be added to the data recovery proposal.

Stan Wilmoth also recommended that the Advisory Council on Historic Preservation (Western Office of Planning and Review, Lakewood, Colorado) be contacted immediately and be presented with the project background and data recovery plan. Paul asked who had the responsibility for making that contact and Stan, citing the 106 process, indicated that it was the responsibility of the lead agency for the project (in this case the EPA). Stan also recommended that the Salish-Kootenai Tribal Historic Preservation Office be contacted immediately again indicating that it was the responsibility of the EPA to make that contact. Paul and Bob asked if Stephen Aaberg could draft letters to the Advisory Council and the Salish-Kootenai THPO for the EPA since he was more familiar with the archaeology of the area and with the language of cultural resource laws. Aaberg agreed to these tasks but indicated a contract amendment would be necessary since these tasks were not part of the original scope of work under the ACRCS-CDM subcontract. Paul indicated the EPA would review and sign these letters. Stan also indicated that a copy of the archaeological data recovery plan and 106 process report (cited in the first paragraph above) should be provided to the Advisory Council and THPO.

Stan Wilmoth also mentioned that after comment by the Advisory Council and the THPO, a memorandum of agreement (MOA) would be the final step in the 106 process which would allow the data recovery project for 24LN1045 to begin. Bob Alexander and Paul Peronard again asked if Stephen Aaberg could draft an MOA for the EPA which they would again review and sign. Aaberg again agreed to the task but indicated that this new task would require a contract amendment.

Finally, Stan Wilmoth gave verbal support to the data/significant information recovery plan presented in the Aaberg report and verbally accepted the proposal (with a few minor changes recommended - described above). Stan also indicated that the Montana SHPO is not the final authority on agreement to data recovery and again emphasized the need to contact the Advisory Council and the Salish-Kootenai THPO.

The meeting adjourned at 3:40 PM. Bob Alexander asked if Aaberg would draft a summary of the proceedings of this meeting.

Sincerely,

Stephen A. Aaberg
ACRCS

Revisions to the data recovery plan were made by ACRCS and the revised report was sent by ACRCS to Stan Wilmoth of the Montana SHPO and to Paul Peronard of the EPA. The letters accompanying the report submittals appear below.

August 10, 2000
Paul Peronard
On Scene Coordinator
U.S. Environmental Protection Agency - Region 8
999 18th Street, Suite 500, 8EPR-ER
Denver, Colorado 80202-2466

Dear Paul:
Enclosed are three copies of the final version of the report on the Section 106 process and the plan for recovery of significant information at 24LN1045. One copy should go to the Advisory Council and one copy should go to the Salish-Kootenai Tribal Historic Preservation Office. I have also enclosed draft versions of the cover letters which should be sent with the reports. You can make any changes or additions to the letters if you feel the EPA needs to make changes and additions. You may want to add some information to the Salish-Kootenai THPO letter summarizing the earlier contact your agency had with the tribe (who was contacted by who etc.). The letters should come from the EPA and should be signed by you or the appropriate agency officer. In the letters I asked for expedited review by both the advisory council and the THPO. In the THPO letter I also mentioned that if acceptable to the tribes some tribal group (likely the THPO) could assemble their history of the Rainy Creek locality. I would assume that I could subcontract with the identified group to write the history and then incorporate it into the final archaeological report.

We need comments from the Advisory Council and THPO before we draft an MOA between the EPA and the Montana SHPO. So the sooner we can get the reports and letters off, the more likely we will get an expedited review. I understand that the dates for hazardous material training have been set for August 22 - 25, 2000 in Libby. Please call if you have any questions.

Sincerely,

Stephen A. Aaberg
Owner and Senior Archaeologist - ACRCS

cc: Peter Borrowed
encl.

August 10, 2000

Stan Wilmoth
Montana State Historic Preservation Office
Montana Historical Society
1410 Eighth Avenue
P.O. Box 201202
Helena, Montana 59620-1202

Dear Stan:

Enclosed is the final version of the report detailing the 106 process and the plan for recovery of significant information at 24LN1045. I made some revisions based on your comments and suggestions. Copies of the report have been sent to the Region 8 office of the EPA and will be forwarded by them to the Advisory Council and to the Salish & Kootenai THPO.

Please call if you have any questions.
Sincerely,

Stephen A. Aaberg
Owner and Senior Archaeologist ACRCS

cc: Paul Peronard, Peter Borowiec

encl.

ACRCS subsequently drafted letters to the Advisory Council and the Salish-Kootenai THPO on behalf of the EPA and sent these draft letters to Paul Peronard. Mr. Peronard reportedly signed the letter and sent it, along with the data recovery plan to the Advisory Council. In a letter dated August 15, 2000, and sent to Timothy Wall of CDM by John McGuiggin of the U.S. Department of Transportation, Research and Special Programs Administration (Volpe Center), it was stated that, "On August 15, 2000, a copy of the Recovery Plan was sent to the Advisory Council and the Tribal Council for review and comment". Presumably, reference to the "Tribal Council" meant that the report and letter had been sent to the Confederated Salish-Kootenai THPO. ACRCS did not receive a copy of the official, final cover letters that presumably accompanied submittal of the Recovery Plan report to the Advisory Council and the Salish-Kootenai THPO. The Recovery Plan cover/submittal letters originally drafted by ACRCS and sent directly to the EPA appears below. It is not known to ACRCS if these draft letters were used verbatim as the EPA Recovery Plan cover/submittal letter that accompanied the Recovery Plan report.

August 8, 2000

Advisory Council on Historic Preservation
Western Office of Planning and Review
12136 West Bayaud Avenue, Suite 330
Lakewood, Colorado 80228

Dear Advisory Council:

The U.S. Environmental Protection Agency, Region 8, is currently administering the Libby, Montana Asbestos Emergency Response Project. The project includes remediation of asbestos contaminated soils at the former W.R. Grace screening plant on the Kootenai River about five miles north of Libby. Remediation includes stripping of contaminated soils to a minimum depth of 18 inches below surface with some pockets of the landscape requiring removal of up to 8 feet of contaminated soils.

Archaeological site 24LN1045, previously determined eligible for listing in the National Register occurs entirely within the location scheduled for remediation. It is anticipated that the entire site will be adversely effected by planned remediation activities.

Enclosed is a report by Aaberg Cultural Resource Consulting Service of Billings, Montana which details the history of investigations of 24LN1045. This report also includes a proposal for recovery of significant information at the site as well as a review of the Section 106 process. We invite your review and comments on this report. Because of local community concerns about the *extreme health and safety hazards posed by asbestos contamination, immediate remediation action is required at the location of the old screening plant. Therefore, we are asking for expedited review of the enclosed archaeological report.*

On Thursday August 3, a meeting was held at the Montana State Historic Preservation Office in Helena, Montana. The meeting was attended by Stan Wilmoth of the Montana SHPO, Paul Peronard of the EPA, Robert Alexander of CDM Federal Programs Corporation (contractor for the EPA), John Constan of the Montana Department of Environmental Quality, and Stephen Aaberg of Aaberg Cultural Resource Consulting Service. The enclosed proposal for recovery of significant information from 24LN1045 was reviewed and discussed at this meeting. Stan Wilmoth agreed in principal with the recovery plan but recommended that the Advisory Council and the Salish-Kootenai Tribal Historic Preservation Council be contacted immediately since their review and comments are necessary in the 106 process. A copy of the enclosed information recovery plan and report has been sent to the Salish-Kootenai THPO.

It is imperative that asbestos remediation progress swiftly. Remediation activities must be completed before inclement winter weather sets in. With your review and comments, we hope to initiate archaeological significant information recovery at 24LN1045 within the next three weeks.

Thank you for your assistance in this process.

Sincerely,

Paul Peronard
On Scene Coordinator
U. S. Environmental Protection Agency
Region 8
999 18th Street
Suite 500, 8EPR-ER
Denver, Colorado 80202-2466

August 8, 2000

Marcia Cross, Tribal Preservation Officer
Confederated Salish & Kootenai Tribal Historic Preservation Office
P.O. Box 278
Pablo, Montana 59855

Dear Ms. Cross:

The U.S. Environmental Protection Agency, Region 8, is currently administering the Libby, Montana Asbestos Emergency Response Project. The project includes remediation of asbestos contaminated soils at the former W.R. Grace screening plant on the Kootenai River at its *confluence with Rainy Creek, about five miles north of Libby. Remediation includes stripping of contaminated soils to a minimum depth of 18 inches below surface with some pockets of the landscape requiring removal of up to 8 feet of contaminated soils.*

Archaeological site 24LN1045, previously determined eligible for listing in the National Register, occurs entirely within the location scheduled for remediation. It is anticipated that the entire site will be adversely affected by planned remediation activities.

Enclosed is a report by Aaberg Cultural Resource Consulting Service of Billings, Montana which details the history of investigations of 24LN1045. This report also includes a proposal for recovery of significant information at the site as well as a review of the Section 106 process. We invite your review and comments on this report. Please note the significant information recovery plan includes a recommendation to sub-contract with the Salish-Kootenai to provide a history of the locality. Because of local community concerns about the extreme health and safety hazards posed by asbestos contamination, immediate remediation action is required at the location of the old screening plant. Therefore, we are asking for expedited review of the enclosed archaeological report. Expedited review would also allow time to set up a sub-contract with the Salish-Kootenai to begin work on a tribal history of the Rainy Creek locality if the tribes elect to participate.

On Thursday August 3, a meeting was held at the Montana State Historic Preservation Office in Helena, Montana. The meeting was attended by Stan Wilmoth of the Montana SHPO, Paul Peronard of the EPA, Robert Alexander of CDM Federal Programs Corporation (contractor for the EPA), John Constan of the Montana Department of Environmental Quality, and Stephen Aaberg of Aaberg Cultural Resource Consulting Service. The enclosed proposal for recovery of significant information from 24LN1045 was reviewed and discussed at this meeting. Stan Wilmoth agreed in principal with the recovery plan but recommended that the Advisory Council and the Salish-Kootenai Tribal Historic Preservation Council be contacted immediately since their review and comments are necessary in the 106 process. A copy of the enclosed information recovery plan and report has been sent to the Advisory Council.

It is imperative that asbestos remediation progress swiftly. Remediation activities must be completed before inclement winter weather sets in. With your review and comments we hope to initiate archaeological significant information recovery at 24LN1045 within the next three weeks.

Thank you for your assistance in this process.

Sincerely,

Paul Peronard
On Scene Coordinator
U. S. Environmental Protection Agency
Region 8
999 18th Street

Suite 500, 8EPR-ER
Denver, Colorado 80202-2466

Sec. 800.4 - Identify Historic Properties

This step, known as "identification" includes preliminary work, actual efforts to identify properties, and an evaluation of identified properties to determine whether they are "historic"; i.e., they are listed on, or eligible for inclusion in, the National Register of Historic Places (NRHP).

This step was completed for Operable Unit 2. Site 24LN1045 was recorded in 1975 and was evaluated and determined eligible for inclusion in the NRHP. The EPA was aware of its presence and began the 106 process early in 2000. However, 24LN1045 was identified and evaluated on its merits as an archaeological site. Native American consultation was not part of the previous investigations of 24LN1045 or the location of Operable Unit 2. Site 24LN1045 was suggested as having potential significance to area Native Americans pending outcome of consultation with them (Aaberg 2000).

It is not known if the identification step has been completed for Operable Unit 1, the vermiculite mine area. Typically the identification step results in determining if on-the-ground cultural resource surveys have been carried out for a particular parcel of land. If a tract of land that will be affected by a proposed undertaking has not been physically inspected then typically a Class III cultural resource inventory is recommended so any potential cultural resources can be identified, recorded, and evaluated for NRHP eligibility. Background research, consultation, and oral history interviews may also be part of the process of cultural resource identification.

Sec. 800.5 - Assess Adverse Effects

The SHPO/THPO and Indian tribes attaching religious and cultural significance to identified properties, must be consulted when agencies apply the criteria of adverse effect. The Agency Official also needs to consider the views of consulting parties and the public.

Adverse effects occur when an undertaking may directly or indirectly alter the characteristics of a historic property that qualify if for inclusion in the NRHP. Reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative also need to be considered. Examples of adverse effects include physical destruction or damage; alteration of a property not consistent with the Secretary of the Interior's *Standards*; relocation of a property; change of use or physical features of a property's setting; visual, atmospheric, or audible intrusions; neglect resulting in the deterioration; or transfer, lease, or sale of a property out of Federal ownership or control without adequate protections.

Section 800.5(2)(ii) of the regulations includes hazardous material remediation as an example of adverse effects to a property. Removal of contaminated soil was proposed for the portion of Operable Unit 2 which encompasses 24LN1045. The entire portion of the site (about

50%) that occurs on the Parker property was affected by asbestos removal. The southern part of the site is owned by KDC and in 2001 discussions were on-going as to whether the EPA or W.R. Grace would be responsible for carrying out remediation activities. That portion of the property is contaminated by asbestos and it is presumed that if remediation has not yet begun, it soon will. It is further presumed that if remediation occurs on KDC property almost the entire site would be adversely affected. Only the small portion of the site that occurs east of the highway would escape disturbance from asbestos removal. It was known that soil removal would generally affect the upper 18" of sediment over most of the site and that some deep pockets of asbestos contamination were present. In the summer of 2000, a number of such pockets were stripped to over 8 feet below surface. Use of wheeled or tracked vehicles for soil stripping and transport to a disposal site were viewed by ACRCS as increasing the depth of disturbance another 12" through soil compaction and rutting. Therefore ACRCS recommended that the area of primary effect be vertically expanded to 30" below surface.

When 24LN1045 was first discovered and recorded in 1975, archaeological materials were noted eroding from 20cm (7.87") below surface to over 1 meter (39.37") below surface (Munsell 1975). During evaluation of 24LN1045 in 1993, subsurface testing took place along Highway 37 in eastern portions of the site and artifactual materials were recovered from 5cm(1.97") to 40cm(15.75") below surface (Griffin and Aaberg 1994). Documented archaeological materials were known to occur well within the vertical area of primary effect.

Archaeological excavation is now considered an adverse effect by the Advisory Council but is allowable as a mitigative measure as long as a well-devised mitigation and data recovery plan is developed and found acceptable by consulting parties. The Montana SHPO reviewed the data recovery plan for 24LN1045 and suggested some revisions but agreed with the essentials of the plan. It was not necessary that the Advisory Council comment on the data recovery plan since the Montana SHPO had accepted the role for review and comment. Although the Salish-Kootenai THPO were sent a copy of the data recovery plan, formal comments on the plan were not received by the EPA prior to the initiation of site excavation and mitigation.

Sec. 800.6 - Resolve Adverse Effects

When adverse effects are found, the consultation must continue among the Federal Agency (EPA), SHPO and consulting parties to attempt to resolve them. Although the Montana SHPO can facilitate consultation with respect to adverse effects, any of the consulting parties can request the Council to join the consultation if agreement among any of the consulting parties cannot be reached. The Council will decide on its participation within 15 days of receipt of a request. Whenever the Council decides to join consultation, it must notify the Agency Official and the consulting parties. It must also advise the head of the Federal agency of its decision to participate. This is intended to keep the policy level of the Federal agency apprized of those cases that the Council has determined present issues significant enough to warrant its involvement.

New consulting parties may enter the consultation if the agency and the SHPO (and the Council, if participating) agree. If they do not agree, it is desirable for them to seek the Council's opinion on the involvement of the consulting party. Any party, including applicants, licensees or permittees, that may have responsibilities under a Memorandum of Agreement must be invited to participate as a consulting party.

The Agency Official is obligated to provide project documentation to all consulting parties at the beginning of consultation to resolve adverse effects. Particular note should be made of the reference to the confidentiality provisions.

The Federal agency must provide an opportunity for members of the public to express their views on an undertaking. The provision embodies the principles of flexibility, relating the agency effort to various aspects of the undertaking and its effects upon historic properties. The Federal agency must provide them with notice such that the public has enough time and information to meaningfully comment.

If all relevant information was provided at earlier stages in the process in such a way that a wide audience was reached, and no new information is available at this stage in the process that would assist in the resolution of adverse effects, than a new public notice may not be warranted. However, this presumes that the public had the opportunity to make its views known on ways to resolve the adverse effects.

Although it is in the interest of the public to have as much information as possible in order to provide meaningful comments, this section acknowledges that information may be withheld in accordance with Section 304 of the NHPA. Under Section 304 information about the location, character, or ownership of a historic resource can be withheld from the public if the Secretary and the agency determine that the disclosure may 1) cause a significant invasion of privacy; 2) risk harm to the historic resource; or 3) impede the use of a traditional religious site by practitioners.

ACRCS has not been included in post-excavation communication between the Salish-Kootenai THPO and the Advisory Council and Montana SHPO. The Salish-Kootenai THPO has communicated orally with ACRCS and has expressed concerns over the way the 106 process was handled by the EPA. The Salish-Kootenai THPO has never formally responded to the portion of the data recovery plan that suggested that the Salish-Kootenai be subcontracted to investigate and write their own history of the Rainy Creek locality.

Sec. 800.6 Memorandum of Agreement

When resolving adverse effects without the Council, the Agency Official (EPA herein) consults with the SHPO and other consulting parties to develop a Memorandum of Agreement. If this is achieved, the agreement is executed between the Agency Official and the SHPO and filed with required documentation with the Council. This filing is the formal conclusion of the Section 106 process and must occur before the undertaking is approved. Standard treatments adopted by the Council may set expedited ways for completing memoranda of agreement in certain circumstances.

When the Council is involved, the consultation proceeds in the same manner, but the agreement of the Agency Official, the SHPO and the Council is required for a Memorandum of Agreement (MOA).

A Memorandum of Agreement evidences an agency's compliance with Section 106 and the agency is obligated to follow its terms. Failure to do so requires the Agency Official to reopen the Section 106 process and bring it to suitable closure as prescribed in the regulations.

Certain parties may be invited to be signatories in addition to those specified as the primary consulting parties. It is particularly desirable to have parties who assume obligations under the agreement become formal signatories. However, once invited signatories sign the MOA, they have the same rights to terminate or amend the MOA as the other signatories.

Other parties may be invited to concur in agreements. They do not have the rights to amend or terminate an MOA. Their signature simply shows that they are familiar with the terms of agreement.

ACRCS stated that the most likely primary consulting parties and signatories for an MOA dealing with adverse effects to 24LN1045 were the EPA, the Montana SHPO, and tribal groups of the Confederated Salish Kootenai (Aaberg 2000).

A draft Memorandum of Agreement (MOA) was prepared by ACRCS on behalf of the EPA. That draft MOA was sent by ACRCS to the Region 8 Office of the EPA attention Paul Peronard on August 18, 2002 and is presented below.

MEMORANDUM OF AGREEMENT FOR RECOVERY OF SIGNIFICANT INFORMATION

FROM ARCHAEOLOGICAL SITE: 24LN1045 (Rainy Creek Site)
UNDERTAKING: Libby, Montana Emergency Asbestos Remediation
STATE: Montana
AGENCY: U. S. Environmental Protection Agency, Region 8

Whereas, in accordance with 36 CFR Part 800, the U.S. **Environmental Protection Agency** acknowledges and accepts the advice and conditions outlined the Council's "Recommended Approach for Consultation on the Recovery of Significant Information from Archaeological Sites," published in the Federal Register on May 18, 1999; and

Whereas, the consulting parties agree that recovery of significant information from the archaeological site(s) listed above may be done in accordance with the published guidance; and

Whereas, the consulting parties agree that it is in the public interest to expand funds to implement this project through the recovery of significant information from archaeological sites to mitigate the adverse effects of the project; and

Whereas, the consulting parties agree that Indian Tribes or Native Hawaiian organizations that may attach religious or cultural importance to the affected property have been consulted and have raised no objection to the work proposed; and

Whereas, to the best of our knowledge and belief, no human remains, associated or unassociated funerary objects of cultural patrimony as defined in the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001), are expected to be encountered in the archaeological work;

Now therefore, the **U.S. Environmental Protection Agency, Region 8** shall ensure that the following terms and conditions, including the appended Archaeological Data Recovery Plan, will be implemented in a timely manner and with adequate resources in compliance with the National Historic Preservation Act of 1966 (16 U.S.C. 470).

OTHER TERMS AND CONDITIONS:

Modification, amendment, or termination of this agreement as necessary shall be accomplished by the signatories in the same manner as the original agreement.

Disputes regarding the completion of the terms of this agreement shall be resolved by the signatories. If the signatories cannot agree regarding a dispute, any one of the signatories may request the participation of the Council to assist in resolving the dispute.

This agreement shall be null and void if its terms are not carried out within 5(five) years from the date of its execution, unless the signatories agree in writing to an extension for carrying out its terms.

U.S. Environmental Protection Agency Official:

Date:

Montana State Historic Preservation Officer:

Date:

Confederated Salish & Kootenai Tribal Historic Preservation Officer:

Date:

ACRCS was first contracted by CDM to review Section 106 laws and statutes applicable to the Rainy Creek Site (24LN1045) in the context of the federal undertaking associated with the Libby Asbestos Project. ACRCS was not contracted to act as Section 106 response agent. The EPA had accepted the responsibility of the lead federal agency in this undertaking. Because of the administrative hierarchy of the Libby Asbestos Project, communication between ACRCS and various project administrative agencies was largely facilitated through the EPA subcontractor, CDM. CDM in turn was required to submit all correspondence and requests to the Volpe Center. To expedite the 106 process ACRCS did draft some letters and documents, as presented above, on behalf of the EPA and some of this correspondence was sent directly to the EPA. ACRCS was not responsible for ensuring that all communication, letters, and documents were forwarded to the appropriate, consulting parties in the 106 process. In the Section 106 process review document generated by ACRCS, and in subsequent communication, the EPA was directed to provide all consulting parties with required documents, reports, and letters.

As mentioned above the John McGuiggan (McGuiggan to Timothy Wall/CDM) letter dated August 25, 2000 indicated that a copy of the Section 106 compliance report and Data Recovery Plan (Aaberg 2000) had been sent to the Advisory Council and Salish-Kootenai THPO on August 15, 2000. ACRCS had earlier sent copies of the revised and final Data Recovery and Section 106 report to the Montana SHPO (letter dated 8/10/00 from Stephen Aaberg to Stan Wilmoth).

Because of the emergency nature of the Libby Asbestos Project and the extreme threat to human health posed by asbestos contamination, all aspects of the asbestos remediation project, including archaeological mitigation, were put on a fast track by the EPA and its contractors. All personnel entering the old W.R. Grace screening plant locality (where 24LN1045 is located), including any archaeological crew, were required to go through Office of Safety and Health Administration (OSHA) Hazardous Materials Operations (HAZWOPER) training. This 40 hour training program required advanced scheduling and the ACRCS archaeological crew was committed to attend four 10-hour sessions beginning August 22, 2000 and continuing through August 25, 2000. Initially ACRCS was assured by the EPA and its contractors that attempts would be made to obtain comments from the Advisory Council and the Salish-Kootenai THPO prior to the beginning of archaeological excavation at 24LN1045.

On August 24, 2000, Stephen Aaberg was informed (telephone) by Peter Borowiec of CDM that the EPA wanted ACRCS to begin archaeological excavation on Saturday August 26, 2000. Aaberg asked if Advisory Council and Salish-Kootenai THPO comments had been received yet and was informed that they had not. On August 25, 2000, Stephen Aaberg met with Jude Hopza (Army Corps of Engineers and EPA screening plant remediation coordinator) at the screening plant remediation facilities. Aaberg expressed that he was hesitant to begin archaeological excavations at 24LN1045 without any official comments or an MOA on the data recovery project from the Advisory Council and the Salish-Kootenai THPO. Mr.Hopza indicated that it was his impression that the EPA did not want to delay asbestos removal because of the health hazard posed to area residents. Mr. Hopza then contacted Paul Peronard by telephone and a three-way conservation took place between Hopza, Peronard, and Aaberg. In the conversation, Mr. Peronard stressed the importance that archaeological excavation begin on August 26, 2000. Aaberg agreed to begin excavations only if the EPA sent a letter to all 106 consulting parties directing ACRCS to begin excavations without comments from the Advisory Council and Salish-Kootenai THPO. Aaberg requested that a copy of such a letter be sent to him before excavations could begin. It was also Aaberg's understanding that attempts would be made by the EPA to continue the consultation process with the Advisory Council and the Salish-Kootenai THPO. Mr. Peronard agreed to Aaberg's requests and stated the letter would be written immediately.

The ACRCS archaeological crew reported to the screening plant remediation site on the morning of August 26. At that time he asked if a copy of the letter had been sent or faxed to the screening plant remediation office. No such letter had been received at the screening plant remediation facility but Mr. Hopza assured Mr. Aaberg that the letter had been drafted and would be received presently. The ACRCS crew began acquiring personal protective equipment necessary to enter the asbestos containment area during the morning and early afternoon of August 26, 2000. Later in the afternoon excavation equipment was transported to the screening plant remediation area and was taken to the north end of 24LN1045, within the asbestos containment area. Screens were set up and excavation units were laid out but excavation did not begin until Sunday, August 27, 2000.

Although Aaberg and ACRCS were assured that a letter had been written informing all 106 consulting parties that the EPA was directing ACRCS to begin archaeological excavations, a copy of the letter was not received by ACRCS until the third week of September 2000. That letter was the letter from John McGuiggan (Volpe Center) to Timothy Wall (CDM) dated August 25, 2000. The concluding paragraph of that letter stated, "EPA has directed the Volpe Center to initiate the information recovery for the archaeological investigation on Saturday, August 26, 2000 without comments from the Advisory Council and the Tribal Council. It is anticipated however, that comments to the plan will be received during the initial phases of the investigation and at that time any minor adjustments to the field activities can be made. Therefore, we are recommending that you commence field activities on August 26, 2000." The copy lines at the bottom of the letter listed Mr. Paul Peronard (EPA) and Steve Aaberg (ACRCS) as recipients of copies of the letter.

To the best of the knowledge of ACRCS, official comments from the Advisory Council or the Salish-Kootenai were never received; nor was there a Memorandum of Agreement executed between the EPA, the Advisory Council, or the Salish-Kootenai THPO. A telephone conference call was put together by CDM in September of 2000 with the intent of obtaining oral comments from the Salish-Kootenai THPO. This conference call took place as archaeological fieldwork was being carried out and included Marcia Cross (Salish-Kootenai THPO), Lorraine Caye (Kootenai cultural commission representative), Paul Peronard (EPA), Peter Borowiec (CDM), Jude Hopza (EPA/ACE), and Stephen Aaberg (ACRCS). During this telephone conversation the Salish-Kootenai were informed of the progress of excavations and were also given a summary of the archaeological findings including a general description of artifacts. The amount (area) of excavation being carried out was also summarized.

During this conversation, the Salish-Kootenai also asked if it would be possible to provide HAZWOPER training for some tribal members. The conference call also included discussions on the final disposition of artifacts. A suggestion was made to approach Mel and

Lerah Parker, who own a portion of the remediation site and a portion of the land on which 24LN1045 occurs, about the possibility of donating artifacts recovered from their land to the Salish-Kootenai. It was also suggested that the Kootenai Development Corporation also be approached about possible artifact donation. Among comments made by Ms. Cross on archaeological investigations at the site were that attempts be made to define the boundaries of 24LN1045. She also asked that southern portions of 24LN1045 (owned by KDC) be adequately sampled by excavation if that area were to be disturbed by proposed asbestos remediation. The original data recovery plan developed for the site did not include archaeological excavation on KDC-owned southern portions of the site because at the time the plan was developed the KDC and EPA had not resolved questions associated with responsibility of remediation on the KDC property. Subsequent to the telephone conference call with the Salish-Kootenai, the EPA requested that ACRCS prepare an amended budget and data recovery plan for the portion of 24LN1045 that occurs on KDC property. This property was known to be contaminated with asbestos and it was likely that remediation stripping of the property would be undertaken by one party or another. An amended budget and data plan for the additional excavation was prepared by ACRCS in September 2000 while archaeological fieldwork was occurring on the north portion of the site. This budget was submitted to CDM by ACRCS and was quickly approved by the EPA and the Volpe Center.

Also discussed by Ms. Cross during the telephone conference call was a suggestion that all artifacts be viewed by members of the Salish-Kootenai THPO and perhaps by some tribal elders. Ms. Cross acknowledged receipt of the Section 106 and Data Recovery Plan for 24LN1045 (Aaberg 2000) and Mr. Peronard agreed to continue informal consultation in the absence of a formal written MOA.

Sec. 800.7 - Council Comment and Agency Response

There are times when consulting parties cannot resolve issues of adverse effects. The head of the agency or an Assistant Secretary or officer with major department-wide or agency-wide responsibilities must request Council comments when the Agency terminates consultation. Section 110(1) of the NHPA requires heads of agencies to document their decision when an agreement has not been reached under Section 106.

The Council and Agency Official may conclude the Section 106 process with an MOA between them if the SHPO terminates consultation.

A THPO usually is only in a position to terminate consultation with regard to undertakings on tribal lands. In those circumstances there can be no agreement with undertakings and adverse effects but the Council will issue formal comments. This provision respects the tribes sovereign status with regard to its lands. Operable Unit 2 is on private land outside any Indian reservation so this regulation is not relevant to the EPA undertaking.

In cases where the Council terminates consultation, the Council has the duty to notify all consulting parties prior to commenting. The role given to the Federal Preservation Officer is intended to fulfill the NHPA's goal of having a central official in each agency to coordinate and facilitate the agency's involvement in the national historic preservation program.

The Council may provide advisory comments even though it has signed an MOA. This provision is intended to give the Council the flexibility to provide comments even where it has agreed to sign an MOA. Such comments might elaborate upon particular matters or provide suggestions to Federal agencies for future undertakings.

The Council has 45 days to provide its comments to the head of the agency for a response by the agency head. When submitting its comments, the Council will also provide the comments to the Federal Preservation Officer, among others, for information purposes.

Recommended Approach for Consultation on Recovery of Significant Information from Archaeological Site 24LN1045

Background

Sections 800.5 and 800.6 of the Council's revised regulations, "Protection of Historic Properties" (36 CFR part 800) detail the process by which Federal agencies (the EPA herein) determine whether their undertakings will adversely affect historic properties, and if they will, how they are to consult to avoid, minimize, or mitigate the adverse effects in order to meet requirements of Section 106 to "take into account" the effects of their undertakings (in this case the Libby Asbestos Project) on historic properties.

One such category of historic properties is comprised of prehistoric or historic archaeological resources. The National Register of Historic Places defines an archaeological site as "the place or places where the remnants of a past culture survive in a physical context that allows for the interpretation of these remains" (National Register Bulletin 36, *Guidelines for Evaluating and Registering Historical Archeological Sites and Districts*," 1993, p. 2). Such properties may meet criteria for a variety of reasons, not the least of which may be significance under Criterion D. Criterion D defines archaeological sites as significant if "they have yielded, or may be likely to yield, information important to prehistory or history" (*National Register Criteria for Evaluation*, 36CFR 60.4).

Site 24LN1045 was evaluated as an archaeological site in 1993 (Griffin and Aaberg 1994). Although Criterion D was not specifically quoted as the determinant of significance, it is obvious the investigators were using the general guidelines of archaeological significance under Criterion D.

In the context of taking into account the effects of a proposed or federally-assisted undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register, potential impacts to archeological sites often need to be considered. Appropriate treatments for affected archeological sites, or portions of archeological sites, may include active preservation in place for future study or other use, recovery or partial recovery of archeological data, public interpretive display, or any combination of these and other measures.

Archeological Sites and Their Treatment

The nature and scope of treatments for such properties should be determined in consultation with other parties, but in the Council's experience they generally need to be guided by certain basic principles:

-The pursuit of knowledge about the past is in the public interest.

-An archaeological site may have important values to living communities and cultural descendants in addition to its significance as a resource for learning about the past; its appropriate treatment depends on its research significance, weighed against these other public values.

-Not all information about the past is equally important; therefore not all archeological sites are equally important for research purposes.

-Methods for recovering information from archeological sites, particularly large-scale excavation, are by their nature destructive. The site is destroyed as it is excavated. Therefore, management of archeological sites should be conducted in a spirit of stewardship for future generations, with full recognition of their non-renewable nature and their potential multiple uses and public values.

-Given the non-renewable nature of archeological sites, it follows that if an archeological site can be practically preserved in place for future study or other use, it usually should be (although there are exceptions). However, simple avoidance of a site is not the same as preservation.

-Recovery of significant archeological information through controlled excavation and other scientific recording methods, as well as destruction without data recovery, may both be appropriate treatments for certain archeological sites.

-Once a decision has been made to recover archeological information through the naturally destructive methods of excavation, a research design and data recovery plan based on firm background data, sound planning, and accepted archeological methods should be formulated and implemented. Data recovery and analysis should be accomplished in a thorough, efficient manner, using the most cost-effective techniques practicable. A responsible archaeological data recovery plan should provide for reporting and dissemination of results, as well as interpretation of what has been learned so that it is understandable and accessible to the public. Appropriate arrangements for curation of archeological materials and records should be made. Adequate time and funds should be budgeted for fulfillment of the overall plan.

-Archeological data recovery plants and their research designs should be grounded in and related to the priorities established in regional, state, and local historic preservation plans, the needs of land and resource managers, academic research interests, and other legitimate public interests.

-Human remains and funerary objects deserve respect and should be treated appropriately. The presence of human remains in an archeological site usually gives the site an added importance as a burial site or cemetery, and values associated with burial sites need to be fully considered in the consultation process.

-Large-scale, long-term archeological identification and management programs require careful consideration of management needs, appreciation for the range of archeological values represented, periodic synthesis of research and other program results, and professional peer review and oversight.

Resolving Adverse Effects Through Recovery of Significant Information From Archeological Sites

Under 36 CFR 800.5, archeological sites may be "adversely affected" when they are threatened with unavoidable physical destruction or damage. Based on the principles articulated above, the Council recommends that the following issues be considered and addressed when archeological sites are so affected, and recovery of significant information from them through excavation and other scientific means is the most appropriate preservation outcome.

The recovery of significant archaeological information from 24LN1045 through excavation and other scientific means is an appropriate outcome. Portions of the site had already been disturbed or destroyed prior to the initiation of data recovery in 2000. About 75% of the site on the north side of Rainy Creek, and about 30% of the site on the south side of Rainy Creek were estimated to have been severely impacted by development prior to 2000. Removal of contaminated soils in 2000 destroyed or disturbed nearly all of the site north of Rainy Creek and nearly all of the site on Parker land south of Rainy Creek. Only a very small portion of 24LN1045 on the extreme east edge of the site had been tested before 2000 and data recovery was minimal. Radiocarbon dates had not been obtained from the site so the absolute ages of cultural deposits were unknown up to 2000. Just a few artifacts had been recovered from the site and the full range of artifacts, representative of activities carried out at the site, was not known. Paleoenvironmental data such as soils data and geomorphological data had not been recovered from the site. Such data helps archaeologists reconstruct past environments and interpret how aboriginal peoples interacted with that environment. This data also helps document changes in the environment and these changes affected all forms of life. Plants were and are very important to Native Americans and some plant species (e.g. bitterroot, camas) were particularly important to local aboriginal peoples such as the Salish and Kootenai. Plant remains are often preserved in archaeological deposits and can be identified through paleoethnobotanical analysis. Such analysis and exchanges of information with native peoples knowledgeable about traditional plant use can help elaborate and interpret activities which were occurring at an archaeological site and if particular events or ceremonies were occurring at the site. Prior to 2000, no attempts had been made to recover such data from 24LN1045. Previous testing carried out at 24LN1045 suggested that intact features with preserved plant and animal remains could be present at the site. Because so little data had been recovered from 24LN1045 recovery of significant information through excavation and other scientific means was viewed as imperative before more of the site were lost to proposed asbestos remediation and associated activities (Aaberg 2000).

In the data recovery plan for 24LN1045 (Aaberg 2000) it was stated that if the following guidance was followed, it was highly unlikely that the Council would decide to enter the consultation process under 36 CFR 800.6 or raise objections to the proposed resolution of adverse effects, unless it (the Council) was informed of serious problems by a consulting party or a member of the public.

1. The archaeological site should be significant and of value chiefly for the information on prehistory or history, it is likely to yield through archeological, historical, and scientific methods of information recovery, including archeological excavation.

Site 24LN1045 had been evaluated as an archaeological site and was found significant primarily for its information on prehistory.

2. The archeological site should not contain or be likely to contain human remains, associated or unassociated funerary objects, sacred objects, or items of cultural patrimony as those terms are defined by the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001).

Such items were not found during evaluative testing in 1993. Recovered objects appeared to be more utilitarian in nature and included cutting and perforating tools associated with animal bone which was likely being consumed by site occupants. Presence of heat-altered rock suggested heating and likely cooking (some of the animal bone was charred) occurred at the site.

3. The archeological site should not have long-term preservation value, such as traditional cultural and religious importance to an Indian tribe.

Native American consultation was not required as part of the evaluation of 24LN1045 in 1993. Prior to 2000 such consultation had not been carried out. Native American consultation is a required part of the Section 106 process for considering adverse effects to the site when a federal agency is involved.

Attempts were made by the EPA to undertake consultation with the Confederated Salish-Kootenai tribe prior to implementation of the data recovery plan. This consultation was not brought to a formal conclusion since comments were not received from the Salish-Kootenai THPO.

4. The archeological site should not possess special significance to another ethnic group or community that historically ascribes cultural or symbolic value to the site and would object to the site's excavation and removal of its contents.

The Section 106 process recommends soliciting public comments on undertakings and the effects they would have on historic properties. Some comments were obtained by a few Libby area residents on concerns about 24LN1045 although as presently understood these comments did not take the form of claims of ethnic or cultural associations and values.

5. The archeological site should not be valuable for potential permanent in-situ display or public interpretation, although temporary public display and interpretation during the course of any excavations may be highly appropriate.

24LN1045 is located on private land and although it was found to be extremely rich in cultural deposits, asbestos contamination essentially precludes the possibility of public interpretation. A portion of the site occurs on property that remains under the ownership of Mel and Lerah Parker who plan to rebuild a home and business there once asbestos remediation is complete. A residential subdivision is a possible future development which would encompass the southern third of the site which is owned by KDC.

6. The Federal Agency Official should have prepared a data recovery plan with a research design in consultation with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*, the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation, and the *Advisory Council on Historic Preservations's Treatment of Archeological Properties: A Handbook.* The plan should specify: (a) The results of previous research relevant to the project; (b) research problems or questions to be addressed with an explanation of their relevance and importance; (c) the field and laboratory analysis methods to be used with a justification of their cost-effectiveness and how they apply to this particular property and these research needs; (d) the methods to be used in artifact, data, and other records management; (e) explicit provisions for disseminating the research findings to professional peers in a timely manner; (f) arrangements for presenting what has been found and learned to the public, focusing particularly on the community or communities that may have interests in the results; (g) the curation of recovered materials and records resulting from the data recovery in accordance with 36 CFR part 79 (except in the case of unexpected discoveries that may need to be considered for repatriation pursuant to NAGPRA); and (h) procedures for evaluating and treating discoveries of unexpected remains or newly identified historic properties during the course of the project, including necessary consultation with other parties.

As part of a contract between Aaberg Cultural Resource Consulting Service and the DOT/Volpe Center (Contract # DTRS57-99-D-000017) a draft data recovery plan and research design for mitigation at 24LN1045 was prepared and submitted to the Montana SHPO, the Advisory Council, and the Salish-Kootenai THPO. That data recovery plan was designed following the guidelines presented above (Aaberg 2000).

7. The Federal Agency Official should ensure that the data recovery plan is developed and will be implemented by or under the direct supervision of a person, or person's, meeting at a minimum the *Secretary of the Interior's Professional Qualifications Standards* (48 FR 44738-44739). The data recovery plan was prepared by ACRCS by staff who meet those standards.

8. The Federal Agency Official should ensure that adequate time and money to carry out all aspects of the plan are provided, and should ensure that all parties consulted in the development of the plan are kept informed of the status of its implementation. A budget for data recovery was prepared by ACRCS and was submitted to the EPA and its contractor CDM.

9. The Federal Agency Official should ensure that a final archeological report resulting from the data recovery will be provided to the SHPO. The Federal Agency Official should ensure that the final report is responsive to professional standards, and to the Department of the Interior's *Format Standards for Final Reports of Data Recovery Programs* (42 FR 5377-79).

Provisions in the budget were made to allow for enough copies of the data recovery report to be provided to the appropriate agencies and consulting parties.

10. Large, unusual, or complex projects should provide for special oversight, including professional peer review.

11. The Federal Agency Official should determine that there are no unresolved issues concerning the recovery of significant information with any Indian tribe that may attach religious and cultural significance to the affected property.

12. Federal Agency Officials should incorporate the terms and conditions of this recommended approach into a Memorandum of Agreement or Programmatic Agreement, file a copy with the Council per Sec. 800.6(b)(iv), and implement the agreed plan. The agency should retain a copy of the agreement and supporting documentation in the project files. Neither a Memorandum of Agreement or Programmatic Agreement were ever executed between the EPA and other consulting parties for data recovery at 24LN1045.

PLAN FOR RECOVERY OF SIGNIFICANT INFORMATION FROM 24LN1045

by
Stephen A. Aaberg

Introduction

Both the original data recovery plan, prepared for the north portion of the site that occurs on Parker property, and the amended data recovery are presented below. Both plans appear verbatim as they were presented in the August and September plans developed by ACRCS.

Data Recovery Plan for the North Portion of 24LN1045

The Rainy Creek Site (24LN1045) is located in northwestern Montana, west of the Continental Divide. In a recent paper at the 2000 Montana Archaeological Society annual meeting, Canadian archaeologist Brian Reeves reviewed and summarized the archaeological record of Montana west of the Continental Divide. Among his concluding statements was one suggesting that the archaeological record of this part of Montana is currently so scant as to prohibit an understanding of the entire history of human use of the area. There simply has been very little intensive investigation of archaeological sites in Montana west of the Continental Divide. Archaeological site excavations have been rare in this area. The sorts of analyses undertaken during archaeological excavation, such as radiocarbon dating, paleoenvironmental studies (e.g. study of soils, study of plant remains, study of geology and geomorphology, study of past climates), study of stone tool use and manufacture, study of lithic or stone sources of material used for tool-making, faunal analysis, ethnobotany and paleoethnobotany have been and continue to be uncommon in western Montana.

The 1993 investigations of 24LN1045 suggest that at least 30% of the site south of Rainy Creek has been destroyed or disturbed by highway and road construction and industrial and residential development (Griffin and Aaberg 1994). The surface survey carried out in July of 2000 indicates that about 75% of the site north of Rainy Creek has been destroyed or disturbed by construction, maintenance, and operation of the vermiculite processing facility and a private nursery and residence constructed subsequent to 1993. Asbestos contamination sampling and testing carried out in late spring and early summer of 2000 indicates that essentially all of the site has been contaminated by this hazardous material. Thus, the entire site will be partially or completely destroyed or disturbed by removal of contaminated soil.

The Rainy Creek Site boundaries were expanded after archaeological testing in 1993 indicated archaeological deposits extended eastward beyond the original 1975 boundaries. In July of 2000 site boundaries were expanded to include much of the landform on the north side of Rainy Creek. Site area grew from 45,000 square meters in 1975 to about 70,000 square meters in 1993. With the additional boundary expansion in 2000 the site area is estimated at about 125,000 square meters. Area sampled through archaeological testing amounts to two square meters or 0.002% of the site. The 1993 investigators believe the area that was sampled by testing is the lowest yielding (in terms of archaeological materials) part of the site (Griffin and Aaberg 1994). The absolute age or ages of the site are not known since radiocarbon dating of cultural deposits has not yet occurred. Time sensitive artifacts recovered in 1993 were fragmentary and allowed for only general comparisons to extant projectile point and cultural chronologies of the area. Studies and analyses described above were not part of the 1993 site evaluation.

Native American participation in proposed significant information recovery is important. Mutual exchange of information and ideas between native peoples and archaeologists is invaluable to interpretation of historic and prehistoric human use of the Kootenai River in the vicinity of 24LN1045. Salish, Kootenai, and Flathead peoples have direct ancestral ties to the landscape in the area of Rainy Creek and the Kootenai River. Their knowledge of their past would be an important contribution to the recovery of significant information from 24LN1045.

How past peoples lived and interacted with the landscape is important to all present peoples. This is probably best stated in a booklet, titled *Archaeology and You*, that was produced by a joint effort of the National Geographic Society, the U.S. Department of the Interior, and the Society for American Archaeology (SAA 1996). This publication states, "Archaeology........helps immensely in addressing the problems of the present. As we know all too well, these range from the threat of global environmental depletion to misunderstanding - or sheer intolerance - between vastly different cultures. What archaeology offers is at least a glimpse, and in some cases a fuller understanding, of how some who came before solved these problems - and how others failed in their effort. That is what archaeology is all about" (SAA 1996:33).

Because the Rainy Creek Site is threatened with potential complete destruction or disturbance, and because so little is known of the prehistory of Montana west of the Continental Divide, it seems as though recovery of significant information from the site is in the public interest. The value of the site to living communities as a resource for learning about the past should be recognized through consultation and communication as a part of the data and information recovery plan.

Data and Information Recovery Methodology and Plan

Because of the obvious threat to public health and safety, asbestos remediation in the project locality is considered an emergency. The nature of the asbestos hazard has resulted in certain obviously justifiable constraints on both the time and intensity of any proposed archaeological mitigation and data recovery. First of all, the EPA considers it imperative to remove the asbestos contaminated soils and deposits at the locality as quickly as possible to minimize the threat to public health and safety. The normal planning process associated with cultural resource mitigation in federal undertakings has been foreshortened in this emergency setting. All planning has been accelerated in the interest of public health so remediation of the hazardous asbestos threat can be completed as quickly as possible. Large scale, relatively long-term archaeological excavations are precluded by time constraints. Secondly, because of the hazard posed by the asbestos-contaminated property at Rainy Creek, access to the property is highly restricted. Only personnel trained and certified in health and safety procedures associated with hazardous materials will be allowed on the property during remediation. Any and all archaeologists participating in on-site excavation and data recovery must be so trained and certified.

1. The first step in the data/information recovery plan should be consulting with the Montana State Historic Preservation Office, the Salish-Kootenai Tribal Historic Preservation Office, and the National Advisory Council on Historic Preservation. The Salish-Kootenai THPO can identify other tribal groups and members, such as elders, who may have important information and oral histories on past use of the landscape in the area of the Rainy Creek Site. The cost proposal for information recovery at 24LN1045 should have a budget item for Salish-Kootenai tribal consultation. Although visits to the site are precluded because of health and safety restrictions, elders and others may wish to spend time on organizing oral histories of the area. If acceptable to the tribe, the budget line item should be used by the tribe to assemble and write a history of the Rainy Creek locality. This history may include some documentation of use of the Kootenai Trail, which reportedly extended up the Kootenai River Valley past the Rainy Creek locality. The Salish-Kootenai THPO should be contacted to determine the appropriate tribal group or groups for compiling this history.

The Rainy Creek Site occurs on private land and legally any artifacts recovered from the site during data recovery belong to the current landowners. However, it may be advisable to discuss with landowners and the Salish-Kootenai tribes the possibility of curating any recovered artifacts at The People's Center museum on the Flathead Reservation. Because of Salish-Kootenai ancestral ties to the Kootenai River area, and because The People's Center is a federally accepted curatorial facility, it would be appropriate and beneficial to all people to have artifacts curated at this facility. A curatorial fee may be necessary if a curation agreement can be reached between private landowners and the Salish-Kootenai. Other curatorial facilities such as the Montana Historical Society in Helena, Montana would also be available for artifact curation if necessary and agreed to by the private landowners.

2. Archaeological data recovery in the form of excavation is recommended for 24LN1045. However, because of time constraints the hand excavated sample will be small. Remediation is scheduled to begin in August and will likely be concurrent with archaeological investigations. Hazardous material training for archaeologists working on site must precede fieldwork and each archaeology crew member must complete 40 hours of training. As presently envisioned by the

EPA, archaeological data recovery would immediately follow the health and safety training. Realistically, only about five days would be available for archaeological excavation following training. Health and safety concerns, and the time involved in training, also preclude fielding a large crew. A crew of four to six archaeologists, including a geoarchaeologist, is the most manageable investigative team considering all of the complexities and concerns associated with a hazardous material remediation project.

Asbestos remediation at the site will include stripping sediments to at least 18" below surface and from four to eight feet in some pockets. Use of heavy equipment for the stripping process would quite likely result in disturbance through rutting and soil compaction to another 12". Therefore, all excavation units should be excavated to a minimum of one meter below surface. In 1993, cultural materials were recovered from about 5cm to 40cm below surface. In 1975, cultural materials in areas near the river were observed to over one meter below surface. Because more deeply occurring cultural deposits may be present at the site it is also recommended that a minimum of two square meters be excavated to 2 meters below surface or until sterile river gravels or bedrock are encountered; or until four consecutive sterile cultural levels below one meter are encountered. It is important to investigate the entire history of human use of the Rainy Creek Site so patterns of behavioral changes and adaptations can be understood within the matrix of past environments.

Excavation on the site landforms should be carried out in 10cm levels and as artifacts are encountered they should be piece-plotted with elevations whenever possible. Excavation may be carried out in natural layers following occupational surfaces if plotting of artifacts or natural soil horizon characteristics indicates presence of such surfaces at certain vertical intervals. Excavation will be carried out using both shovel shaving-techniques and toweling (when occupation surfaces, features, artifact concentrations, etc. are found). Sediments removed from cultural strata will be dry-screened through 1/8" mesh. Stratigraphic profiling will be carried out on two perpendicular walls of each excavation unit. All artifacts, with the exception of fire-broken rock, will be collected and bagged with all provenance data recorded. Fire-broken rock will be counted and characterized (including size range) for each level and/or occupation by excavation unit.

A minimum hand-excavation sample of six square meters (0.005% of the total site area) is recommended for this data recovery project. Of these six square meters, four square meters should be hand excavated into the portion of the site that occurs south of Rainy Creek. At least three square meters of that minimum sample should be excavated in overbank sediments marginal to the Kootenai River where archaeological deposits appear to be most dense. At least one square meter of that minimum sample should be placed in central or eastern portions of the site south of Rainy Creek, where alluvial fan deposits occur.

A minimum of two square meters should be hand excavated into the portion of 24LN1045 that occurs north of Rainy Creek. All hand excavation should occur at the north edge of the site where archaeological deposits in apparently undisturbed context were observed in 2000. The remainder of the portion of the site north of Rainy Creek appears to be far too disturbed to allow for optimum data recovery.

with paleoclimatic models for the region. The presence of bone in some site deposits within the alluvial terraces, as well as the perceived potential presence of charcoal as suggested by fire-broken rock, should allow for adequate radiometric dating of the site. Bone is present in cultural deposits at the site and could be used for radiometric dating in the absence of charcoal. Even if dateable organics are not recovered, the likely presence of culturally diagnostic artifacts on site landforms will allow for association with culture histories and typologies for the region.

If obsidian artifacts are recovered from the site, sourcing analysis is recommended. Sourcing could allow for interpreting trade systems and contact between peoples of other areas of the Plains and Intermountain region.

Modeling of Holocene and Late Pleistocene Kootenai valley evolution and terrace and alluvial fan development in this area has been posed by others (Cochran and Leonhardy in Roll 1982; Thoms 1984). Buried cultural components in alluvial landforms at 24LN1045 presents an opportunity to determine ages of landforms, and through analysis of soils, compare site geoarchaeological interpretations to those just cited.

Soils analysis is important in determining conditions under which soils formed. Pedogenic variables can be correlated to paleoclimatic models developed for the Northern Plains and Intermountain region. Geoarchaeological investigation of 24LN1045 is recommended. Geoarchaeological and soils investigation and documentation will include profiling and soil description and analysis of each excavation unit and should be augmented by backhoe trenching which will be carried out by EPA remediation contractors and subcontractors during their concurrent work on the property. All backhoe trenches will be recorded and investigated by the project geoarchaeologist. Soil samples and radiocarbon samples will be collected from the trenches when appropriate. If deeply buried cultural deposits are found attempts will be made to collect radiocarbon dates from backhoe exposed cultural strata. At least two backhoe trenches should be excavated to basal gravels if possible. Since asbestos remediation will involve removal of up to eight feet of sediment in some areas, it is anticipated that geoarchaeological investigation could occur in those areas. Geoarchaeological backhoe trenching will not exceed 0.4% (500 square meters) of the total area of 24LN1045. Backhoe trenching by asbestos remediation contractors in areas of deep asbestos contamination may exceed the 0.4% figure since this construction work will be determined by the depth and lateral extent of asbestos contamination. Geoarchaeological analysis of backhoe trenches will allow for paleoenvironmental interpretations and should help determine the evolution and development of the Kootenai River Valley. Any deeply occurring cultural deposits will be documented through profiling as well as radiocarbon dating (if dateable materials are found). Analysis of backhoe trenches could provide management data for future protection of the site if cultural deposits are found to occur below the zone of asbestos remediation. In the absence of trench analysis presence of deeply occurring cultural deposits will remain undetermined as will the early paleoenvironmental history of the locality.

4. Once excavation, fieldwork, all technical analyses, and Native American consultation have been completed the results and information should be organized into a report that follows all standards for archaeological reporting. The report should include a section on the history of the project locality. Archival research and documentation on historic Native American use of the

area as well as the white trading and settlement of the area should be included. As mentioned earlier, the Ben Thomas homestead is believed to have been present at the mouth of Rainy Creek. There is some evidence to suggest that an early trading post (not Kootenay House) was briefly located near Rainy Creek. A historic Native American trail is also known to have passed through the Kootenai River valley. All these elements of the history of the area, and any others, should be researched and documented in the report. If the Confederated Salish-Kootenai Tribes elect to sub-contract to produce a history of tribal use of the project area, this document should be incorporated into the overall cultural resource report detailing recovery of significant information at 24LN1045. It is important that enough copies of this report be produced to ensure that all consulting and cooperating parties be provided with one. It is recommended that a budgetary allowance for the production of 30 copies of the report be included in the proposal. It is further recommended that within two years of the completion of the technical report a report be prepared for publication in local or regional professional journals such as *Archaeology In Montana* or *Plains Anthropologist.*

Data Recovery Plan for the South Portion of 24LN1045

What ACRCS describes as the south portion of the Rainy Creek Site is that portion of the site, south of Rainy Creek, that occurs on property owned by the Kootenai Development Corporation (KDC) of Libby, Montana. This portion of the site occupies the area between State Highway 37 and the Kootenai River and extends southward from the KDC property line to the north edge of an old river meander scar that is also partially occupied by a gravel pit.

Although 24LN1045 was known to extend into this south area, this area had never before been tested or evaluated. The EPA wished to include this KDC property in the asbestos remediation project, as it was known to be likely contaminated with asbestos and vermiculite. The property was once owned entirely by W.R. Grace but recently became jointly owned by Grace and KDC. This portion of the site had been substantially modified and impacted by W.R. Grace during construction of a large water pumping station and subsequent reclamation work carried out with heavy equipment. The nature and extent of disturbance had not been determined but based on surficial examination it appeared that portions of the archaeological site were either undisturbed or minimally disturbed.

At the time the original data recovery plan for 24LN1045 was developed, the EPA had not received permission from KDC to investigate the south property and KDC had not granted permission to expand the remediation project to the property. As archaeological excavations were being carried out on northern portions of 24LN1045, the EPA and KDC came to an agreement to allow asbestos contamination testing to go forward and also agreed to allow archaeological excavation on their property. Since the original archaeological significant information recovery plan did not include that portion of 24LN1045 on KDC property, the EPA asked ACRCS to prepare an amendment to the recovery/mitigation plan for the south area. In a telephone conversation in early September, Marcia Cross, Salish-Kootenai THPO, stated that it was important to determine the site boundaries and offered her support for additional archaeological excavations in the southern portion of the site.

While in the field carrying out data recovery on northern portions of 24LN1045, ACRCS prepared an additional scope of work and mitigation plan to cover portions of the site that occur on KDC property. Archaeological methodologies were to follow those set forth in the original recovery plan. The scope of work for additional fieldwork in the south portion of the site is presented below.

Three square meters of hand excavated excavation units will be placed south of the Parker-KDC property line. At least one square meter will be placed at the extreme south end of the site to the southeast of the old pumping station. Hand excavated units will be taken to one meter below surface. Site boundaries (exclusive of areas east of Highway 37) will be determined through hand excavation and backhoe trenching. Three to five backhoe trenches will be placed in southern portions of the site. It is estimated that an additional 7 to 10 days of field time will be necessary to complete this additional fieldwork. The enclosed cost estimate also includes additional costs for reporting and additional technical analyses (e.g. radiocarbon dating, blood residue analysis, faunal analysis, obsidian sourcing, paleoethnobotanical analysis, artifact description and analysis, geoarchaeological analysis) as defined in the original significant information recovery plan. The estimate also includes additional crew living expenses (per diem), mileage/travel, telephone, field supplies, film/development, report production, postage, and Native American consultation.

Modifications to Data Recovery and Archaeological Research for 24LN1045

The overall budget for the Libby Asbestos Emergency Response Project experienced some reductions, in part because of unanticipated expenses the EPA was facing following the events of September 11, 2001. As a result, ACRCS was asked to find ways of reducing the budget for data recovery at 24LN1045. The budget for archaeological research and analysis associated with the report phase of data recovery at 24LN1045 was subsequently reduced. Among those analyses that were not carried out because of the budget reduction was inspection of constant volume sediment samples collected from each hand excavated level. It was hoped that flotation analysis and plant macrofossil and microfossil analysis could be carried out on these samples. The budget reduction together with the risk of asbestos contamination of the samples prevented analysis. The samples were retained and are available for future analysis, which if undertaken, should be carried out in an asbestos abatement environment where personal protection gear is used. It was also hoped that samples of volcanic ash collected from some of the backhoe trenches excavated at the site could be submitted for definitive identification. The costs for carrying out such identification were higher than expected so ash analysis was not undertaken. Finally, the bone recovered from 24LN1045 during the 2000 excavations was submitted to a subcontracted faunal specialist in Lincoln, Nebraska for analysis in February of 2001. The faunal subcontractor failed to complete or submit a report and failed to return the bone after repeated requests to do so. Therefore, this report does not include a detailed discussion of faunal remains. It is hoped that the faunal remains will be returned with the hope that detailed analysis can be carried out in the future. A catalog of bone material was developed before these materials were sent to Nebraska and some basic faunal identification was carried out by ACRCS prior to submittal to the faunal analyst.

ENVIRONMENTAL SETTING AND NATURAL HISTORY

by
Stephen A. Aaberg and William P. Eckerle

Regional Geography

24LN1045 Legal Description: Lincoln County, Montana (Figures 1, 2 and 3)
NE1/4 Section 32, Township 31 North, Range 30 West (primarily private ownership with a small portion of site within Montana Department of Transportation, State Highway 37 right-of-way)

The Rainy Creek Site (24LN1045) is 10 km (6.25 mi.) east of Libby, Montana (Figures 1, 2 and 3), and occurs within the Northern Rocky Mountains Physiographic Province (Fenneman and Johnson 1946) where anticlinal structures and intermountain basins form the ranges and valleys, respectively (Thornbury 1965). Flat-floored, structurally-controlled valleys (trenches) occur and are sometimes several miles wide. The area surrounding Libby is also classified as part of the Northern Rocky Mountains eco-region (McNab and Avers 1994). This area is composed of rugged, high mountains, where elevations sometimes exceed 2,700 m (9,000 ft.). Regionally, the relief between the mountain peaks and the river valleys is in excess of 900 m (3,000 ft.). Continental and alpine glaciation occurred during the Pleistocene (Alden 1953; Alt and Hyndman 1986).

The site occurs at the mouth of Rainy Creek where it enters the Kootenai River, which heads on the west side of the Canadian Rocky Mountains approximately 365 km (227 mi.) to the north. From its headwaters, the river flows nearly due south within the Rocky Mountain Trench, a north-south trending structural depression bounded by the Salish Mountains to the west and the Whitefish Range to the east. After the river leaves the Rocky Mountain Trench near the town of Rexford, Montana, it enters a canyon between the Salish Mountains (east) and Purcell Mountains (west). It continues southward until the confluence of the north-flowing Fisher River, where the Kootenai River makes a sharp turn west (known as the "great", or "big", bend). This confluence is 14.6 km (9 mi.) upstream from the project area, and 6.3 km (3.9 mi.) downstream from Libby Dam at the south end of Koocanusa Reservoir. Fisher River drains the east flank of the Cabinet Mountains and the south part of the Salish Mountains. Below Fisher River, the Kootenai River continues a westerly course and is joined by north-flowing Libby Creek at the town of Libby. Just southeast of Troy is the mouth of Lake Creek, where the river flows northwesterly. In Idaho, the Kootenai enters the Purcell Trench west of Bonners Ferry and flows northward into Canada. North of Creston, British Columbia, the river discharges into Kootenay Lake, then drains out of the lake's west arm to continue a southwestern course before joining the Columbia River near Castlegar, British Columbia.

Montana State Highway 37 runs along the east edge of 24LN1045 generally forming the east site boundary (Figures 4 and 5). A small portion of the south part of the site (south side of Rainy Creek) extends across the highway where a few flakes were evident in the road cut (Figure 5). A Forest Service and mining access road passes up Rainy Creek to the Vermiculite Mountain area. The Burlington Northern railroad runs along the west side of the Kootenai River opposite

Rainy Creek. The site area was the location of an old apple orchard as well as the location of a vermiculite screening plant (asbestos remediation in 2000 and 2001 has essentially obliterated all evidence of the orchard and screening plant facilities).

Local Vegetation

Küchler (1966) mapped the general area of the site as a composite of elevationally controlled vegetation types organized into well defined life belts. Western ponderosa pine (*Pinus*) forest occupies the river valleys, sagebrush (*Artemisia*) and grass occurs on some of the drier lower slopes, and Douglas fir (*Pseudotsuga*) forest dominates lower mountain slopes. A mixed evergreen-deciduous forest predominates at higher elevations and is composed of two major vegetation types: Douglas-fir forest and cedar-hemlock-Douglas-fir forest.

The Rainy Creek Site setting can be described as a relatively dry setting where the well-drained alluvial fan soils support a mixture of xeric and mesic species. A narrow, but dense riparian zone is present along Rainy Creek and along the margins of the Kootenai River. Historically, the locality has seen extensive disturbance, primarily from vermiculite processing relating activities and construction. Southern portions of the site are likely more representative of the vegetation community that once occupied most of the site area. The alluvial fan in that area supports a light stand of mixed conifer forest that is dominated by Ponderosa pine (*Pinus ponderosa*). Douglas fir (*Pseudotsuga menziesii*) and Rocky Mountain juniper (*Juniperus scopulorum*) were also noted. A nearly one hundred year old apple orchard occupied a portion of the property along the south side of Rainy Creek.

The riparian zone along Rainy Creek and immediately marginal to the Kootenai River supports several species of willow (*Salix* spp.), cottonwood (*Populus angustifolia*), water birch (*Betula occidentalis*), alder (*Alnus cf. viridis*), black hawthorn (*Crataegus douglasii*), Red-osier dogwood (*Cornus stolonifera*), chokecherry (*Prunus virginiana*), snowberry (*Symphoricarpos* sp.) and thimbleberry (*Rubus parviflorus*). Serviceberry (*Amelanchier alnifolia*) is common on the fan surface and in the riparian zone as are several species of wild rose (*Rosa* spp.). Grouse whortleberry (*Vaccinium scoparium*) was noted on the mountain slopes bordering the east edge of the site as was at least one other species of blueberry/huckleberry (*Vaccinium* sp.). Several specimens of a species of elderberry (*Sambucus* sp.) were also observed on the site surface. Other berry species noted in site areas include gooseberry and currant (*Ribes* spp.), Oregon grape (*Mahonia repens*), russet buffaloberry/soapberry (*Shepherdia canadensis*) and kinnikinnick (*Arctostaphylos uva-ursi*).

Additional species observed at a reconnaissance level include arrow-leaf balsamroot (*Balsamorhiza sagittata*), lupine (*Lupinus* sp.), Rocky Mountain maple (*Acer glabrum* var. glabrum), wolf willow (*Elaeagnus commutata*), yellow sweet-clover (*Melilotus officinalis*), cheat grass (*Bromus tectorum*), wildrye (*Elymus* sp.), goldenrod (*Solidago* spp.), horsetail/scouring rush (*Equisetum* spp.), senecio/groundsel (*Senecio* spp.), thistle (*Cirsium* spp.), penstemon (*Penstemon* spp.), wild lettuce (*Lactuca* sp.), agoseris (*Agoseris* sp.), sedges (*Carex* spp.), flannel mullein (*Verbascum thapsus*), (potentilla (*Potentilla* spp.), scirpus/bulrush (*Scirpus* sp.), western yarrow (*Achillea millefolium*), aster (*Aster* sp.), mountain mahogany (*Cercocarpus* sp.), ninebark

(*Physocarpus malvaceus*) and a variety of native and introduced grasses and weeds. A conspicuous non-native weedy species present in site environs is knapweed (*Centaurea*).

Many of the native plant species listed above were important historically (and continue to be important) to Salish and Kootenai peoples as well as other Intermountain and Plains tribes (Moerman 1998). The berry species present within the boundaries of 24LN1045 would have been an attractive resource for aboriginal peoples. However, most of these species are not restricted in occurrence and are quite common in many environments in the Kootenai Valley, on valley slopes, and along tributaries.

Fauna

Others have discussed the diverse and considerable fauna of the Middle Kootenai region (Thoms and Burtchard 1987; Roll 1982; Roll and Smith 1982). A review of those investigations indicates that historic modern and historic big game species and major carnivores present in Montana west of the Continental Divide includes bison (*Bison bison*), mountain goat (*Oreamos americanus*), caribou (*Rangifer tarandus*), moose (*Alces alces*), whitetail deer (*Odocoileus viginianus*), mule deer (*Odocoileus hemionus*), mountain sheep (*Ovis canadensis*), black bear (*Ursus americanus*), grizzly bear (*Ursus arctos*), pronghorn antelope (*Antilocapra americana*), coyote (*Canus latrans*), mountain lion (*Felis concolor*), wolf (*Canis lupus*), and elk (*Cervus elephus*). Nearly all these species were or are present in the Middle Kootenai region. Populations of bison and pronghorn antelope were likely low compared to some of the other species. Grasslands capable of supporting large numbers of grazers are limited with the most expansive grasslands in the area of the Tobacco Plains north of the project area. Bison were unquestionably present west of the divide, most notably in the upper Blackfoot River drainage, as is indicated in the archaeological record (Aaberg 1985). However, two previous archaeological investigations in the Middle Kootenai area did not conclusively identify any bison remains (Thoms and Burthchard 1987; Roll 1982; Roll and Smith 1982).

Other mammalian species known to occur in the Middle Kootenai area include beaver (*Castor canadensis*), mink (*Mustela vison*), muskrat (*Ondatra zibethicus*), otter (*Lutra canadensis*), pine marten (*Martes americana*), fisher (*Martes pennanti*), cottontail rabbit (*Sylvilagus nutallii*), snowshoe hare (*Lepus americanus*), striped skunk (*Mephitis mephitis*), porcupine (*Erithizon dorsatum*), and weasel (*Mustela* spp.). A variety of smaller rodents including moles, voles, mice, ground squirrels, chipmunks, and tree squirrels are also present in the region.

Blue and ruffed grouse are among the more common upland game birds in the area although seasonally varieties of waterfowl are common. Songbirds are common and varied as are raptors.

The middle reaches of the Kootenai River supports a variety of native fish including western cutthroat trout (*Salmo clarki lewisi*), rainbow trout (*Salmo gairdneri*), Dolly Varden (*Salvelinus malma*), mountain whitefish (*Prosopium williamsoni*), white sturgeon (*Acipenser transmontanus*), burbot (*Lota lota*), largescale sucker (*Catostomus macrocheilus*), longnose sucker (*C. catostomus*), torrent sculpin (*Cottus rhotheus*), slimy sculpin (*C. cognatus*), redside shiner (*Richardsonius balteatus*), northern squawfish (*Ptychocheilus oregonensis*), peamouth chub (*Mylocheilus caurinus*), and longnose dace (*Rhinichthys cataractae*). Roll (1982:4.16-4.17) believes only the mountain whitefish and largescale sucker occur in enough abundance to have been a significant food source.

One species frequently sighted within the boundaries of 24LN1045 during the 2000 field season was whitetail deer. The Kootenai River valley bottom is known to have offered significant winter range for deer and based on observations in 2000, the valley is attractive year-round habitat for deer. Although mule deer were also observed, sightings in the valley bottom were far less frequent than for whitetail deer. Another species that was abundant within the valley bottom environs of 24LN1045 was cottontail rabbit.

Climate

Climate of the study area is continental and characterized by cold, wet winters and warm, dry summers. The average temperature of the coldest month is below 0° C (32° F), and the average temperature of the warmest month is below 22° C (72° F). Mean maximum January and July temperatures are -1° C (30° F) and 30° C (86° F), respectively (National Oceanic and Atmospheric Administration 1985). Mean minimum January and July temperatures are -11° C (12° F) and 7° C (45° F). Average precipitation is 510 to 1,020 mm (20 to 40 in.) per year with most occurring during the cold months in the form of snow. During the warm months, westerlies draw dry air masses over the area creating dry conditions.

Soils

Soils of the area reflect the effects of regional soil formation processes (Montagne et al. 1982). Steeper upland soils are formed into glacial till or residuum derived from Precambrian, predominantly carbonate-rich, sedimentary rocks. Loess and volcanic ash are common parent materials on more flat-lying landforms. Soil and temperature regimes are conducive to the formation of weathered Bw horizons in post-glacial era soils which may develop into Inceptisols. Alluvium derived soils occupy the river valleys, some of which contain buried, organic-rich, A horizons classified as Fluvents.

Geology and Geologic History

Site 24LN1045 is located on the north side of the Kootenai River at the mouth of Rainy Creek (Figures 1, 2, 3, 4, and 5). This portion of the Kootenai River flows within a narrow canyon, between the Purcell Mountains to the north and the Cabinet Mountains to the south. Both of these ranges are dominated by sedimentary rocks deposited during the Precambrian while valleys are mantled with Tertiary and Quaternary sediments (Ross et al. 1955). The Precambrian Belt supergroup was deposited 1.5 to 1.4 billion years ago in a huge intracratonic basin that stretched across western Montana, northern Idaho, eastern Washington, and southern Canada. This basin was filled by sand, silt, clay, and carbonate sediments that are extremely thick in places. In addition, a Cretaceous igneous intrusion dated at about 90 million years old occurs northeast of the site at Vermiculite Mountain (Alt and Hyndman 1986).

The great bend of the Kootenai flows around the southern end of the Purcell Mountains, which are a relatively coherent structural block predominantly composed of Ravalli group and Wallace formation in the Belt supergroup (Gibson et al. 1941). The former is largely quartzite and siliceous shale while the latter is limestone, dolomite, quartzite, argillite, and siliceous shale. Small exposures of the Missoula group overlie these rocks and consist of impure quartzite and limestone.

Bedrock in this region was probably deformed when the Okanogan microcontinent collided with the western margin of north America approximately 100 million years ago (Alt and Hyndman 1986), resulting in large northwest and north trending folds and faults (Gibson et al. 1941; Johns 1970). The Purcell Trench, Purcell Anticlinorium, and Rocky Mountain Trench formed at this time (Alt and Hyndman 1986). Mountain building in the region became more intense during the period between 90 and 70 million years ago. Another flurry of geologic mountain building activities occurred in portions of Montana about 50 million years ago.

The Cabinet Mountains were formed largely during the first intense period of orogeny about 90 to 70 millions years ago. A major fault, the Moyie thrust, developed in the area, and is associated with uplifting that created the Cabinet Mountain alpine area, one of the highest areas in northwestern Montana (ibid.).

By about 50 million years ago, the configuration of the Rocky Mountains and drainage systems of northwestern Montana were largely in place. In some portions of western Montana, a brief period of mountain building (largely uplifting) occurred about 20 million years ago. It is not clear to what degree this uplifting affected the mountains of the project area, but in areas of southwestern Montana the Continental Divide shifted westward a considerable distance and portions of some drainages actually changed their direction of flow. The Kootenai River drainage was likely well established by this time although it may have closed through infilling during two very dry periods which occurred 20 to 40 million years ago and again about 10 millions years ago (Alt and Hyndman 1986).

It was the onset of the "ice age" during the Pleistocene, about 2.5 million years ago that gave area mountains and drainages their final appearance. There is no evidence in Montana for the very early episodes of glaciation although they likely affected the region. The last two glacial advances, which occurred between 130,000 and 70,000 years ago and between 20,000 and 10,000 years ago affected large areas of western and northern Montana.

Three types of glaciers affected the region during these two glacial periods. Continental ice sheets advanced southward from Canada. The continental ice sheet which covered the area east of the Rocky Mountain front is referred to as the Laurantide Ice Sheet. The continental ice sheet which covered mountainous portions of northwestern North America is referred to as the Cordilleran Ice Sheet and was formed by coalescence of many piedmont glaciers in the Canadian Rockies and Cascade Range. These continental ice sheets were essentially continuous over vast areas. Piedmont or alpine glaciation occurred in many mountainous areas of Montana. Alpine glaciers developed and moved independent from the continental ice sheets and were present in the Cabinet Mountains (which escaped Cordilleran glaciation) and higher elevations of other area ranges.

In Montana the Laurantide Ice Sheet affected about the northern third of the state east of the Rocky Mountain Front. The Cordilleran Ice Sheet covered the northwestern portion of Montana and extended to the north edge of the Cabinet Mountains (MSU 1978). The Cour D'alene lobe of the Cordilleran Ice Sheet was responsible for damming of the Clark Fork drainage and creation of Glacial Lake Missoula. Geologists are not absolutely certain that Glacial Lake Kootenai, which formed in the Kootenai Valley and its tributaries upstream from the Idaho border, was a separate lake formed by Cordilleran ice in Idaho's Purcell Valley, or if it was part of Glacial Lake Missoula.

Mountain ranges surrounding the Flathead Valley area and the ranges of Glacier Park separated the Cordilleran Ice Sheet from the Laurantide Ice Sheet. However, alpine glaciation occurred in those ranges as it did in most of the higher ranges of western Montana. A finger of the Cordilleran Ice Sheet pushed down the Kootenai River Valley and split, with one lobe moving down the Flathead River and Lake valley to the vicinity of Polson, and the other moving down the Kootenai valley. Fingers of the Kootenai Lobe extended up Libby Creek. Smaller mountain glaciers formed in tributary valleys like Swamp Creek and upper Libby Creek and moved down to join the Kootenai Lobe. Evidence indicates that a mountain glacier formed near the divide between the Kootenai and Flathead drainages in the area of the Thompson Lakes. West of the divide, this glacier moved northwesterly down the valleys of Swamp Creek, Libby Creek, and Fisher River (Alt and Hyndman 1986). East of the divide, this glacier moved easterly down Ashley Creek, past McGregor Lake, and joined the massive Flathead Valley glacier. The Thompson Lakes, McGregor Lake, Schreiber Lake, and other small lakes in the project area likely formed as these mountain glaciers melted leaving large blocks of wasted ice that formed depressions which filled with lake water.

Although both the Purcell and Cabinet Mountains were glaciated during the last ice age, their appearances are very different as the Purcells were subject to continental glaciation and the Cabinets to alpine glaciation. The result is that the Cabinet Mountains are full of sharp peaks, whereas the Purcell Mountains are more rounded. As mentioned, the Kootenai River valley was also glaciated, but now has a V-shaped cross-section implying significant post-deglaciation incision (Alt and Hyndman 1986).

Distinctive mineralogical suites in the watershed of Rainy Creek influence the composition of the alluvial fan at 24LN1045. Vermiculite Mountain is a Cretaceous igneous intrusion called a ring dike that was emplaced into the Precambrian Wallace formation (Boettcher 1967). The intrusion consists of a series of ultramafic rocks (composed predominantly of the mineral pyroxene), is partially capped by white syenite, and is cored by a mass of biotite (Alt and Hyndman 1986). The biotite has been hydro-thermally altered into vermiculite, which has been mined extensively. Hydrothermal alteration of the stock also produced tremolite asbestos, a fibrous amphibole that is a serious threat to human life if inhaled. The asbestos co-occurs with vermiculite in the Vermiculite Mountain area. Asbestos contamination, the focus of EPA remediation of the area encompassing 24LN1045, was a result of mining and processing vermiculite.

Previous Geomorphological and Geological Investigations

Landforms and deposits along the Kootenai River valley immediately downstream from Libby Dam (and upstream from site 24LN1045) were documented as part of the Libby Additional Units and Reregulating Dam archaeological project (Cochran and Leonhardy 1982; Roll (ed.) 1982). In this study, investigators identify three major late Quaternary landforms of archaeological significance: (1) complex glacio-fluvio-lacustrine terraces, (2) "normal" river terraces, and (3) alluvial fans (Cochran and Leonhardy 1982). Although Cochran and Leonhardy (1982) correlate deposits and soils between sites in the Kootenai River valley, Mierendorf et al. (1987) caution that stratigraphic units must be defined in conjunction with pedogenic studies and presence/absence of volcanic glass in order to be accurate. In fact, it simply may not be possible to accurately correlate time-stratigraphic units at different sites, as considerable variation was observed in pedogenic and geomorphologic features (Mierendorf et al. 1987).

Nevertheless, complex glacial-age fluvio-lacustrine terraces contain interbedded glacial, fluvial, and lacustrine deposits (Cochran and Leonhardy 1982). Kennedy Gulch (T4) and Tony Peak (T3) terraces are 37-40 m and 24-37 m (respectively) above the current river channel of the Kootenai River. T4 terraces are characterized by coarse gravels and finely laminated sands, silts, and clays, whereas T3 terraces are composed of gravels interbedded with stratified, coarse grained sand (Cochran and Leonhardy 1982).

Post-glacial age, "normal" river terraces occur below these older landforms, and include: T2 (5-7 m) and T1 (2-4 m) terrace treads (Cochran and Leonhardy 1982). The T2 terrace is composed of a fining upward sequence of gravel, medium grained sand, and silt, which usually contains a deposit of Mount Mazama ash somewhere in the sequence. Stratified deposits can be relatively dated based on the presence of Glacier Peak-Layer G ash (11,250 B.P.) and the Mount Mazama ash (6845 B.P.), although the latter is frequently turbated by tree tip-out (Burtchard 1987). Terrace T1 is composed of basal gravel overlain by interbedded sand and silt (Cochran and Leonhardy 1982). Rip-up clasts of Mount Mazama ash sometimes occur in these sediments, and probably reflect erosion of T2 deposits during high water events or slope wash.

Alluvial fan sediments occur at nearly every tributary mouth and grade into T2 terrace deposits (Cochran and Leonhardy 1982). A late Pleistocene to late Holocene age is suggested for the alluvial fan deposits.

Paleoenvironmental Background

A review of regional environmental change during the late Pleistocene and Holocene facilitates interpretation and discussion of the paleoenvironmental history of the site later in the report.

Full Glacial

As summarized above, at least several times during the Pleistocene, glacial ice flowed south from the Canadian Rocky Mountains and invaded the northern Montana. In northwestern Montana, ice sheets interacted with local alpine glaciation. Glaciation had far reaching effects on the area including burial of the pre-glacial landscape, damming of drainages (which produced glacial lakes), diversion of drainages, deposition of glacially transported rock, and production of proglacial alluvium and windblown silt (loess). As well, the area experienced periglacial conditions that included permafrost and the lowering of vegetation zones in the proglacial zone.

The terminus of the Cordilleran Ice Sheet oscillated near the project area during the height of Late Wisconsin (Isotope Stage 2) glaciation (Clayton and Moran 1982; Harris 1985; Vreeken 1986). A split jet stream produced an anticyclone over the ice mass that resulted in a predominant easterly circulation pattern (CLIMAP Project Members 1976). Winters were not significantly colder than those of the present but summers were much cooler with annual temperatures 10° C lower than those of today. Permafrost was probably widespread in areas more proximal to the ice front (Mears 1981; Péwé 1983). Streams, many of them proglacial, carried greater flows and were of higher competency because of the summer wastage of the glacier. Winter flows were probably severely diminished. Forests were generally restricted to areas along the Northern Rocky Mountain front during the height of glaciation (Barnosky et al. 1987) and steppe tundra probably existed on the plains to the south and east (Mears 1981).

The final Wisconsin stadial is designated as the Fraser glaciation in the Pacific Northwest, and limiting dates are approximately 17,500 B.P. and 11,000 B.P. (Waitt and Thorson 1983). During the Fraser, the Cordilleran ice sheet was composed of several coalescent ice masses. The most important for the project area were the adjacent Kootenai East and Kootenai West glaciers. The Kootenai East glacier flowed south, down the Rocky Mountain Trench, then into and down the Kootenai River canyon (Alden 1953). It flowed up the Fisher River and even extended south into the headwaters of the Little Bitterroot River. The West Kootenai glacier flowed south down the Purcell Trench and spread southeast up the Kootenai River and south into the Bull Lake valley spilling over into the Bull and Thompson Rivers. The West and East Kootenai glaciers joined in the vicinity of Libby Creek and their ice flowed southward a few miles up this drainage. These coalescent ice masses engulfed all but the tallest peaks in the Purcell Mountains to the north of the Kootenai River valley (Alt and Hyndman 1986). During this time, alpine glaciation was extensive in the Cabinet Mountains south of the Kootenai River valley with alpine ice from the northern Cabinets abutting Cordilleran ice west of Libby Creek and glacio-fluvial discharge from the southern Cabinets flowing down Fisher Creek where it was dammed by the ice sheet.

Meanwhile, the ice lobe occupying the Purcell Trench in Idaho extended south of the Kootenai River valley where it overtopped the drainage divide and spilled into the Clarks Fork/Pend Oreille basin, thus damming the Clarks Fork River. This dam persisted for several millennia forming Glacial Lake Missoula behind it (Alden 1953; Bretz 1969). Periodic failure of the ice dam led to catastrophic floods (jökulhlaups) which flowed out across the Columbia Plateau producing the Channeled Scablands (Bretz 1969). During intervals when Glacial Lake Missoula refilled, its shoreline extended up tributary valleys of the Clarks Fork River where its waters abutted the face of the Cordilleran Ice Sheet.

Deglaciation

By about 14,000 B.P. (before present), warming in the Northern Hemisphere brought about retreat of the ice sheet, rejoining of the jet stream(s), and weakening of the anticyclone (COHMAP Project Members 1988). Deglaciation occurred in an alpine cirque in the Mission

Mountains before 11,200 B.P., where Hypsithermal conditions prevailed between 10,850-4750 B.P. (Gerloff, et al. 1995). Other locations in the Northern Rockies suggest a Younger Dryas-age cirque advance (Davis 1988). Carrara (1989) documents near-complete recession of Pleistocene glaciers into cirques by 11,200 B.P. within Glacier National Park. He also notes present-day, proglacial, cirque moraines that contain a mantel of Mazama ash suggesting some earlier advance, probably correlatable to the Younger Dryas-age advance noted by Gerloff (Gerloff et al. 1995).

During deglaciation, the Kootenai glacier retreated northward, out of the headwaters of the Clarks Fork River. The Kootenai valley exhibits little glacial sculpting and is more V-shaped in cross section in contrast to more typical, U-shaped glacial valleys. This anomalous cross section profile has been attributed to the resistant nature of the bedrock and post-glacial incision of the Kootenai River (Alden 1953; Cochran and Leonhardy 1982).

During portions of the deglacial era, the shoreline of Glacial Lake Missoula was still high enough so that its waters backed up to the Clarks Fork/Kootenai River divide south of the project area. As the Kootenai glacier receded downstream (north) along Lake Creek, Libby Creek, and Fisher River, proglacial lakes formed behind it (Waitt and Thorson 1983).

Eventually, the East Kootenai glacier retreated from the project area but the Purcell lobe of the West Kootenai glacier continued to prevent drainage downstream to the northwest. Thus, a large lake filled Kootenai canyon and the Fraser era drainage of this lake was diverted south over the Bull Lake pass (south of Troy) into the Clarks Fork (Alden 1953). The recession of both the East and West Kootenai glaciers deposited sediment in recessionary fan-deltas. Eventually, the ice retreated up the Purcell Trench, allowing the Kootenai River to resume its pre-glacial course. Shortly thereafter, the river rapidly entrenched into, and eroded, the former lake plain recessionary fan-delta. Remnants of this lake plain are prominent near Libby, where they stand 60-90 meters (200-300 ft.) higher than the present river channel. A huge amount of sediment was eroded from the canyon during the post-glacial era (Cochran and Leonhardy 1982). Two terrace remnants upstream from the project area are attributed to deglacial-age glacio-fluvio-lacustrine (i.e. glacial, fluvial, and lacustrine) sedimentation (Cochran and Leonhardy 1982).

Latest Pleistocene/Earliest Holocene

Continued hemispheric warming caused the jet stream to migrate north of its average present position (COHMAP Project Members 1988). By 12,000 B.P. the ice sheet was far northeast of the Canadian border. Complex general circulation patterns emerged in the western United States (Davis and Sellers 1994; Thompson et al. 1993) with the Pacific Northwest experiencing very dry conditions and a more moist climate prevailing on the eastern Great Plains (Whitlock and Bartlein 1993). Grasslands were well established on the eastern slope of the Northern Rocky Mountains by 12,000 B.P. (Barnosky 1989). Whitlock and Bartlein (1993) suggest that present-day summer-wet (winter-dry) areas experienced increased summer moisture, whereas winter-wet (summer-dry) areas, like the project area, became drier in the summer. Bison began evolving to a smaller form, a trend that continued through the early Holocene (Wilson 1975). On the plains, carrying capacity for grazers (notably bison) was higher than at any other period during human occupation (Eckerle 1997).

Pollen cores from south of the Kootenai River (i.e. from the head of Libby Creek and near the head of the Fisher River) indicate that the area was ice free by the time the Glacier Peak-G ash was deposited at about 10,540 B.P. (Mack et al. 1983). White bark pine dominated during this earliest detectable era of post-glacial vegetation colonization. Somewhat drier conditions followed between 11,000-7100 B.P., with two detectable communities: one dominated by Douglas fir (*Pseudotsuga*) and the other by sagebrush (*Artemisia*).

Early Holocene

A more northerly jet stream flow continued into the early Holocene (COHMAP Project Members 1988). In many areas, this was generally a period of increased warming and drying (MacDonald 1989; Reider 1990). Data from mountainous areas of southwestern Alberta indicate an increase in aridity between 9400-8000 B.P. Xeric grasslands were present on some parts of the northwestern Great Plains by 9000 B.P. (Barnosky 1989). Whitlock and Bartlein (1993) suggest that some areas which today have a summer-wet climate, continued to support mesic vegetation through the early Holocene. Winter wet areas like the Libby area were more xeric. Pollen cores from the Cypress Hills of southern Saskatchewan indicate presence of a mesic *Populus* forest-grassland complex at 9000 B.P. (Sauchyn and Sauchyn 1991). Significant stream incision began with isostatic rebound of the continent following glaciation. In the Kootenai River valley, Holocene floodplain deposits are found as high as ten meters above the current river channel "...and are cut-and-filled into late Pleistocene glacial deposits" (Cochran and Leonhardy 1982:2).

Middle Holocene

The period from approximately 7500 to 4500 B.P. is known as the Altithermal interval (Antevs 1955). Aridity prevailed between 7700-5000 B.P. in the Cypress Hills (Sauchyn and Sauchyn 1991). Grasslands replaced forest in the foothills of southwestern Alberta between 8000-5000 B.P. (MacDonald 1989). Barnosky (1989) indicates that xeric grasslands persisted on the northwestern Great Plains from 9000-6000 B.P., at which time more mesic conditions returned. Whitlock and Bartlein (1993) suggest that early Holocene mesic conditions began to give way to aridity on the summer-wet northwestern Great Plains during this time and conversely, in winter-wet areas a shift to more mesic conditions is predicted. Pollen samples south of the Kootenai River valley indicate that lodgepole (*Pinus contorta*) and Ponderosa (*Pinus ponderosa*) pines dominated between 7100 and 4000 B.P. (Mack et al. 1983).

Mount Mazama, a volcano in southwestern Oregon, was active between 7200 and 6800 B.P. A climactic eruption at 6845 +/- 45 B.P. resulted in caldera collapse (i.e. now known as Crater Lake Caldera) as well as the introduction of volcanic ash into the air (Bacon 1983). Mazama ash was deposited as far to the east as Fort Benton, Montana (Alt and Hyndman 1972). Mount Mazama ash deposits have been documented in the Kootenai River drainage basin (Cochran and Leonhardy 1982; Mierendorf et at. 1987).

Late Holocene

After 6000 B.P., modern jet stream patterns essentially became established (COHMAP Project Members 1988). A more mesic flora returned to most locations after the Altithermal (Barnosky 1989; Pielou 1991). Moister and cooler climatic conditions prevailed in the southwestern Alberta foothills after 5000 B.P. In the Cypress Hills, conifer and aquatic taxa increased with the beginning of a more moist post-5000 B.P. climate (Sauchyn and Sauchyn 1991). South of the Kootenai River valley, pollen studies indicate that more moist conditions occurred from 4000 - 2700 B.P. when Grand fir (*Abies grandis*) and Engelmann spruce (*Picea engelmannii*) dominated (Mack et al. 1983). The modern forest community (dominated by *Tsuga heterophylla*) emerged after 2700 B.P. Last and Schweyen (1985) document decreased salinity in some internally drained lakes in Saskatchewan during the early and middle Neoglacial. Relatively arid conditions, Pielou's (1991) "Little Climatic Optimum", returned as early as 1800 B.P. in the upper Midwest, although a much later onset of 900 B.P. is more commonly suggested for some parts of the American West (Graumlich 1993). A final period of increased effective precipitation, known as the Little Ice Age, occurred between 500 and 150 B.P. (Pielou 1991).

Local Physiography and Geomorphology

Site 24LN1045 occupies an alluvial fan at the mouth of Rainy Creek (Figures 4 and 5). This creek bisects the site and flows south from the Purcell Mountains, joining the Kootenai River at 24LN1045. Rainy Creek heads 8.4 km (5.2 mi.) to the north-northeast of the site on the south slopes of Blue Mountain (elevation = 1840 m/6040 ft.). Important tributaries to Rainy Creek enter from the east and include Fleetwood and Carney Creeks, which bound the north and south sides (respectively) of Vermiculite Mountain (Boettcher 1967). Vermiculite Mountain (elevation = 1305 m/4280 ft.) is 4.2 km (2.6 mi.) north-northeast of the site. Vegetation on the fan includes Douglas fir, Ponderosa pine, cottonwood, chokecherry, rose, juniper, and huckleberry. Figure 8 illustrates regional vegetation patterns. Soils are mapped as Calcic Haploxerolls, Andeptic Cryoboralfs, and Typic Eutrochrepts (Figure 9).

Relatively narrow, but rounded ridges and steep timbered slopes characterize the Rainy Creek drainage basin. The river valley near the mouth of the creek is only 0.8 km (0.5 mi.) wide. Steep, rocky, sparsely timbered, southwest-facing slopes form the Kootenai valley wall upstream and downstream from the mouth of Rainy Creek. A remnant of the T3 Tony Peak Terrace (Cochran and Leonhardy 1982) occurs directly across the river (west) from the site, at 24.4-30.5 m (80-100 ft.) above the channel. The Kootenai River drops about 1.5 m per km (8 ft./mi.) as it passes the site. The river bed is composed of bedrock outcrops and small bouldery to coarse cobbly sized gravel, although boulders to very large are also present. Gravel bars and sandy floodplain deposits flank the river channel.

The site occupies a large alluvial fan that is 200 m (656 ft.) from head to toe (west-southwest to east-northeast) and 550 m (1804 ft.) wide (north-northwest to south-southeast). The fan toe is truncated by river erosion resulting in a scarp. The top of this scarp, which is the modern fan surface, stands at approximately 637.8 m (2092 ft.) and is approximately 5.5 m (18 ft.) above the riverbank. The apex of the alluvial fan surface where it exits its canyon is at an elevation of 651.2 m (2136 ft.). Surface slope on the fan is a 13.4 m (43.9 ft.) drop over 200 m (656 ft.). Rainy Creek is incised 1.8 m (6 ft.) at the fan apex to an elevation of 649.4 m (2130 ft.). The stream confluence with the Kootenai River is at an elevation of 632.3 m (2074 ft.). Thus, the channel of Rainy Creek drops an elevation of 17.1 m (56.1 ft.) in 200 m (656 ft.) or 3.7 m (12.1 ft,) more than the slope of the fan surface. This elevation difference suggests that the alluvial fan (and Rainy Creek) graded farther out into the central axis of the valley before the fan

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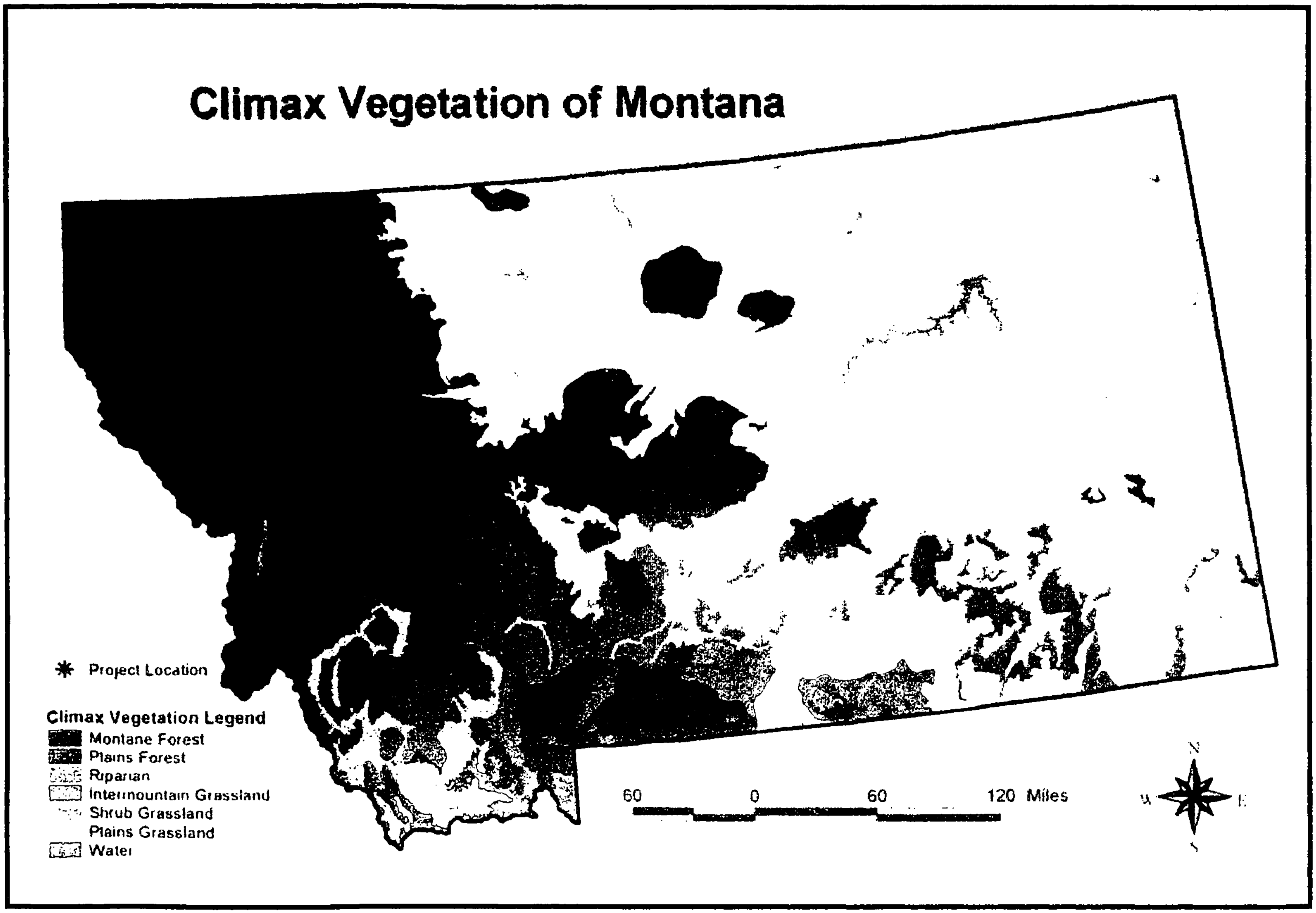


Figure 8: Vegetation of Montana with project region (data from Montana State Library 1993).

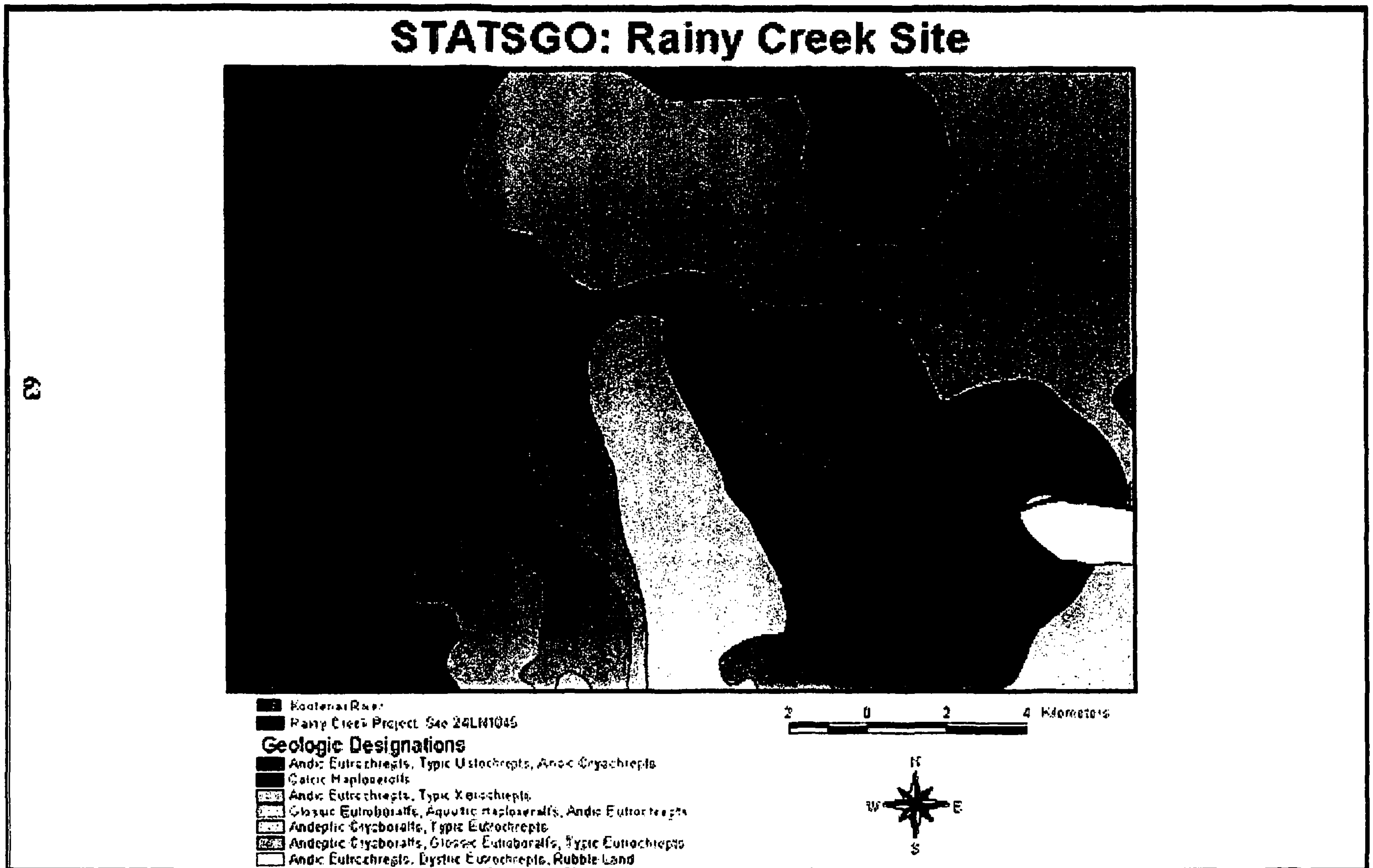


Figure 9: Soils map (STATSGO) of project area [Data from Soil Cionservation Service 1994.

was trimmed back by the river. The edge of the river abuts the entire fan toe scarp, except for the small terraces described next. Within the boundaries of 24LN1045 there is no floodplain development along the narrow and deeply incised channel of Rainy Creek.

A 3 m (10 ft.) high T1 alluvial terrace is present immediately upstream from the mouth of Rainy Creek. This terrace remnant occupies a cove formed from the truncated toe of the alluvial fan to the northeast and the riverbank on the southwest. The fan toe scarp which bounds the northeast side of the terrace is 4.9 m (16 ft.) high. Some historic disturbance has modified the T1 tread. Historic features include a linear, 1 m (3.28 ft.) mound of dirt that parallels the north-south fence-line as well as a 15.2 m (50 ft.) diameter mound of vermiculite which occupies the northeastern edge of the terrace. A pit infilled with vermiculite is also present near the west-central edge of T1. Vegetation of T1 consists of riparian meadow species. A possible T2 terrace grades to the fan toe scarp at an elevation of about 637.20m, 6.71 m above the river. It is vegetated with chokecherry, cottonwood, Douglas fir, and grasses on the east edge of the T1 terrace. A likely remnant of the T1 terrace is present farther upstream in the vicinity of Unit S-5. A floodplain (T0) abuts the river side of the T1 terrace. The surface of the floodplain is approximately 1.2 m (4 ft.) above the river, and is vegetated by willow and sedge.

About 90% of the site occurs on the alluvial fan while about 10% encompasses the T1 and possible T2 alluvial terraces. The site landforms have experienced substantial disturbance over the past approximately 90 years. About 85% of the site on the north side of Rainy Creek has been disturbed by construction of buildings and roads associated with vermiculite screening and storage. This disturbance ranges from surficial grading and blading to the construction of foundations, tunnels, water lines, power lines, gas lines, and a conveyance system that extend to as much as 10' below the original surface. Additional disturbance ranging from shallow to very deep resulted from excavation of fill dirt and backfilling with vermiculite debris.

About 70 to 75% of the south side of Rainy Creek has also been badly disturbed. The first disturbance occurred almost 100 years ago when a homestead and associated apple orchard were constructed. Construction of utility lines and an asphalt loading area also significantly affected the southern property. Fill dirt borrowing and backfilling are also evident in the southern portion of the site. An embayment for the main water pumping station occurs near the southwest corner of the property. This embayment was formed by constructing an artificial jetty. Sediments were borrowed from southwestern portions of the property to construct this jetty. Reclamation activities in the 1990s resulted in dozing and blading of large areas of the alluvial fan in the south part of the site. Vermiculite debris was used as fill to re-sculpt some areas. Bulldozer scars are still evident as is an artificial scarp created by dozing sediments toward the edge of the Kootenai River.

Natural Stratigraphy and Pedology

Stratigraphy

As mentioned above, the modern channel of the Kootenai River is composed of small boulders (25.6-51.2 cm [10.1-20.2 in.]) to coarse cobbles (25.6-12.8 cm [5-10.1 in.]) that are well sorted and strongly clast-supported. This sediment is thought to reflect lag deposition and fluvial reworking of the Pleistocene glacio-fluvio-lacustrine terraces, Holocene fluvial terraces, and Holocene alluvial fan deposits. Remnants of the Pleistocene valley fill form the ca. 24-40 m high terraces described by Cochran and Leonhardy (1982) (i.e. T4 and T3) that formed in early post-glacial times, probably between 12,000-10,000 B.P. These terraces are composed of small boulders to large cobbles with interbedded sand, silt, and clay (Appendix A; Table 2).

Based on the geometry of the fan, there appear to be significantly thick buried fan deposits present at the mouth of Rainy Creek. A valley cross section is illustrated in Figure 10. The fan is thickest near its apex at the canyon mouth where Rainy Creek crosses Montana Highway 37. Here the fan surface rests at 18.3 m (60 ft.) above the Kootenai River channel. The geoarchaeological backhoe observation pit in the north area of the site (Figure 4) penetrated 2.5 meters below the surface of the fan (Figures 11 and 12). Relative aging of fan sediments is aided by the presence of a distinct volcanic unit, suspected Mount Mazama ash, elsewhere dated to 6845 $\pm$ 50 B.P., that is 130 cmbs (centimeters below surface) at this location. Thus, an estimated 17 m of pre-6845 B.P. sediment occurs below the ash, 15.8 m of which is below visual observation. Unfortunately, the fan toe scarp is heavily vegetated and machine stripping for geological observation was not possible due to EPA concerns over water contamination. Thus, the deeper fan sediments were not observed and their nature can only be estimated.

The deepest sediments in the fan (Appendix A; stratum I; Table 3) probably date to the early deglacial era. During this period, the landscape probably exhibited a raw appearance due the lag time between ice sheet withdrawal, lake drainage, valley incision, and vegetation colonization. Eolian reworking of unvegetated till and glacio-lacustrine sediment would have produced a loess enriched environment. Loess mantled slopes would have been very susceptible to slope transport during snow runoff and heavy rains. Debris flows of gravelly silt are envisioned as being very common during this early period and probably constitute the bulk of fan aggradation (i.e. stratum I) during the first millennium (~11,000-10,000 B.P.). Subsequent to the establishment of Holocene vegetation communities, sediment transport on the slopes would have been more predominant during arid periods when vegetation coverage was reduced and forest fires were more common.

Stratum IIb is the lowest unit visible in the portion of the site north of Rainy Creek (Figures 11 and 12). It is also exposed in Trench 4 of the south part of the site. This unit is very dark grayish brown, pebbly gravel to medium grained sand that is discontinuous, even, to uneven, nonparallel bedded and contains some Stage II calcium carbonate (Appendix A; Table 4). Depositional environment is interpreted as alluvial fan channel margin or overbank. Stratum IIb was deposited during the latest Pleistocene to early Holocene. Sub-strata IIa and IIc are alluvial fan deposits that were present but too small to graphically render on any of the illustrated stratigraphic sections (see Appendix A; Table 4). Stratum III overlies stratum IIb and the contact between the two units is sharp.

Stratum III is brown, massive, slightly pebbly sandy silt that is slightly oxidized (Appendix A; Table 5). This unit is a volcanic ash-rich alluvial fan deposit, containing suspected ash from the eruption of Mount Mazama at 6845 $\pm$ 50 B.P. and probably dates to the middle Holocene. Ash-rich Stratum III was identified in two backhoe trenches, the North Trench on the north side of Rainy Creek where it lay from 122 to 142cm below surface and in Trench 4 on the

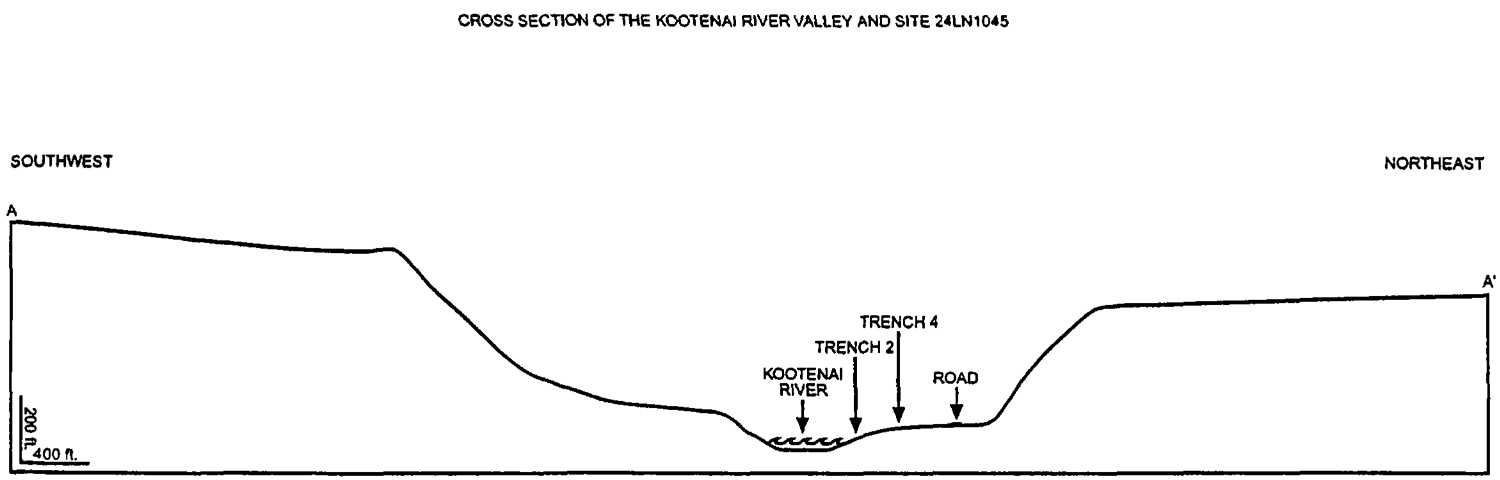


Figure 10: Cross section of valley bottom through the Rainy Creek alluvial fan. Cross section line (A-A') is shown on Figure 3. Horizontal and vertical scale bars on lower left of diagram.

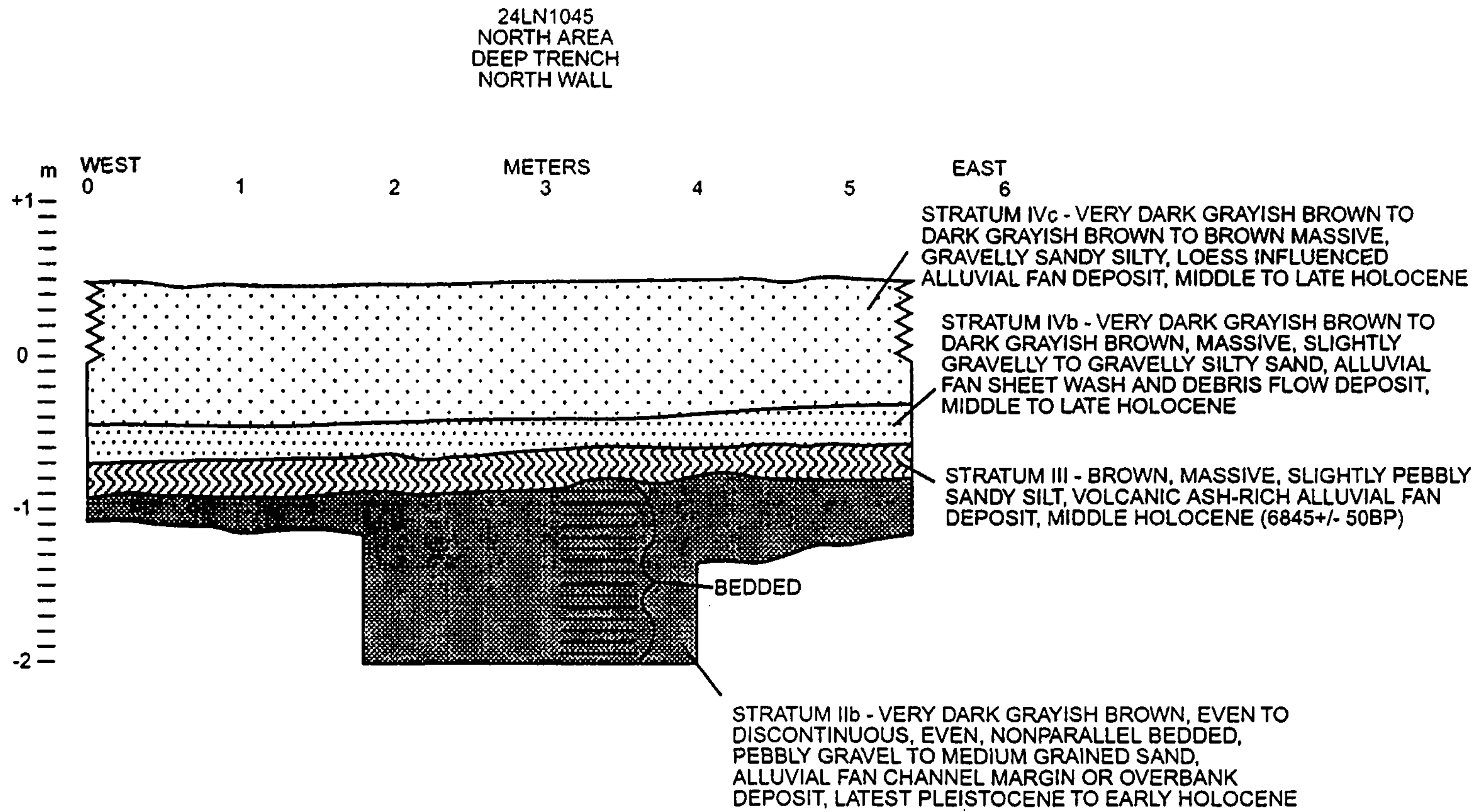


Figure 11: Profile of north wall deep trench, north area, site 24LN1045.

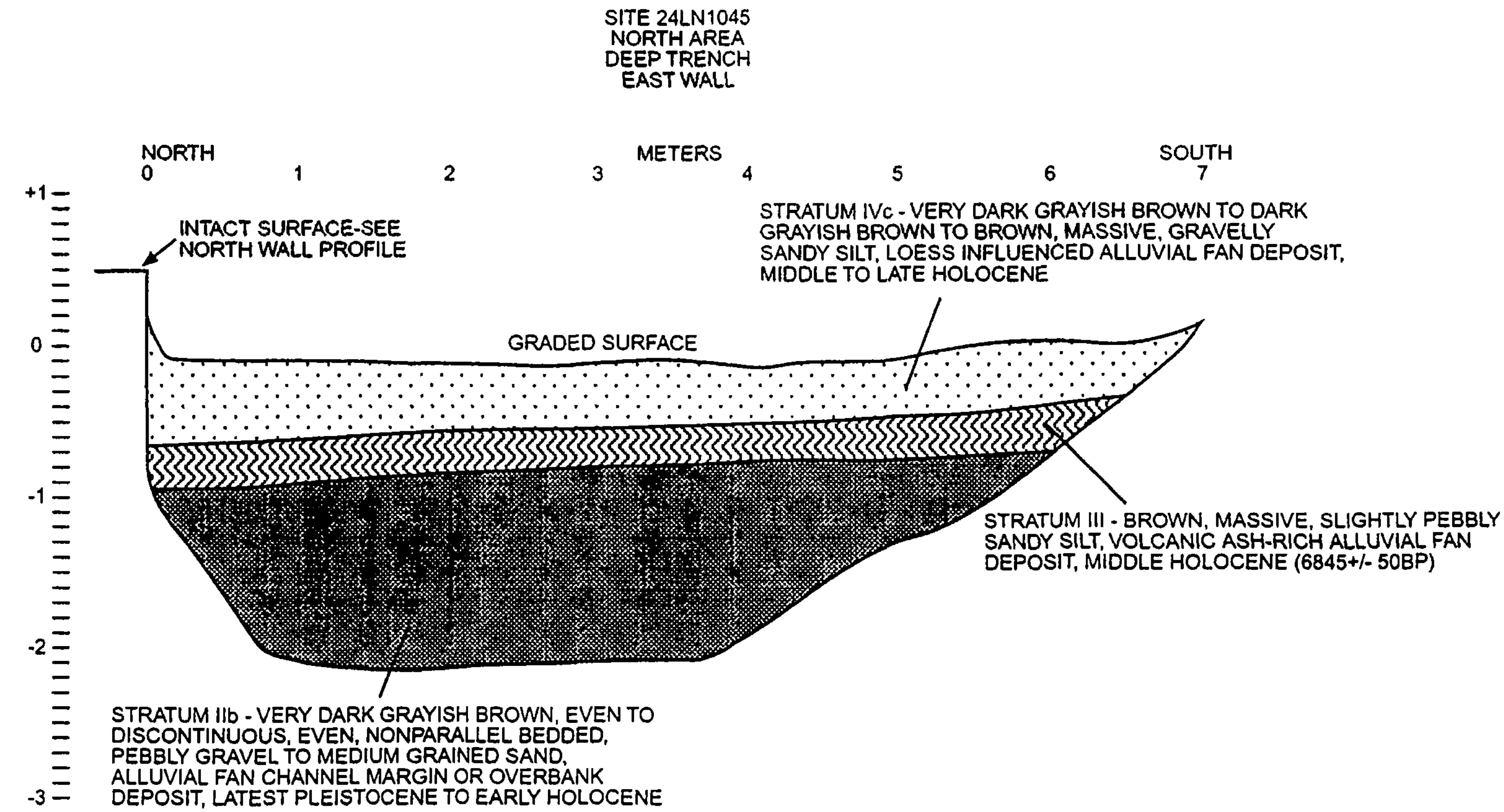


Figure 12: Profile of east wall of deep trench, north area, site 24LN1045.

south side of Rainy Creek where it lay from 113 to 118cm below surface. Stratum III is in sharp contact with overlying stratum IV, which is divided into three sub-strata (Appendix A; Table 6).

Stratum IVa is very dark grayish brown to dark grayish brown to yellowish brown, single grained to weakly bedded, slightly gravelly to gravelly coarse grained sand. Depositional environment is alluvial fan channel. Stratum IVb is very dark grayish brown to dark grayish brown, massive, slightly gravelly to gravelly silty sand deposited by sheet wash and debris flow events in an alluvial fan environment. A radiocarbon date of 1810 ± 50 B.P. was obtained from a fire pit in Trench 3 (37-38 m) in the south area of the site (Figures 5, 13, 14, and 15). Stratum IVc is very dark grayish brown to dark grayish brown to brown, massive, gravelly sandy silt. Depositional environment is interpreted as loess-influenced alluvial fan. Radiocarbon dating of organic paleosols (see below) in stratum IV indicate it was deposited during the middle to late Holocene, with pedogenesis during the late Holocene. In addition, Feature 1 in stratum IVc of Test Unit S-5 produced a radiocarbon date of 320 ± 60 B.P.

Stratum IV is in sharp contact with stratum V, a fining upward sequence of dark gray to grayish brown to dark grayish brown, pebbly medium grained sand to sandy silt (Appendix A; Table 7). Depositional environment of stratum V is interpreted as fluvial overbank and probably correlates to the late Holocene. Table 8 provides a summary of the strata characteristics described above.

Soils

Three horizon profiles were recorded at site 24LN1045 (North Trench, Trench 1, and Trench 3). Moisture and temperature regimes are xeric and thermic, respectively. In addition, several organic paleosols occur in Trenches KDC-1 (Figure 16) and KDC-2 (Figure 17 and 18), and two were subjected to radiocarbon dating. Horizon Ab2 (125-136 cmbs) in Trench KDC-1 produced a date of 3720 ± 50 B.P., and horizon Ab/Awb (118-121 cmbs) in Trench KDC-2 is dated at 2860 ± 60 B.P.

In the North Trench (Figures 11, 12, 19, 20 and 21), four horizons occur: A, C1, C2, and C3 (Appendix A; Table 9). Horizon A (0-13 cmbs) is black, massive, gravelly loamy sand that is an accumulation of humified organic matter with a significant mineral component. Its lower boundary is clear and wavy. Horizons C1 (13-30 cmbs), C2 (30-50 cmbs), and C3 (50-80 cmbs) are very dark grayish brown, very gravelly loamy sand. All C horizons lack structure but have diffuse, smooth lower boundaries. The coarse grained sediment component (i.e. >2mm) increases with depth from 30% at the top of the profile to 75% at the bottom. Horizon A contains some vermiculite, and FCR occurs in the upper part of horizon C1. All horizons occur within stratum IVc. This soil is classified as an Andepic Cryorthent

In Trench 1 of the south area at site 24LN1045 (Figures 22 and 23), eight horizons occur: Ap, Bw1, Bw2, Bw3, C1, C2, C3, and C4 (Appendix A; Table 10). Horizon Ap (0-5 cmbs) is dark grayish brown to very dark grayish brown sandy loam with moderate, fine platey structure. This organic horizon has been recently disturbed by anthropogenic activity. Horizon Bw1 (5-9 cmbs) is dark grayish brown to very dark grayish brown sandy loam with moderate, medium subangular blocky structure. Next is horizon Bw2 (9-19 cmbs), a dark grayish brown, loamy very fine sand with moderate, coarse angular blocky structure. This is underlain by Bw3 (19-32

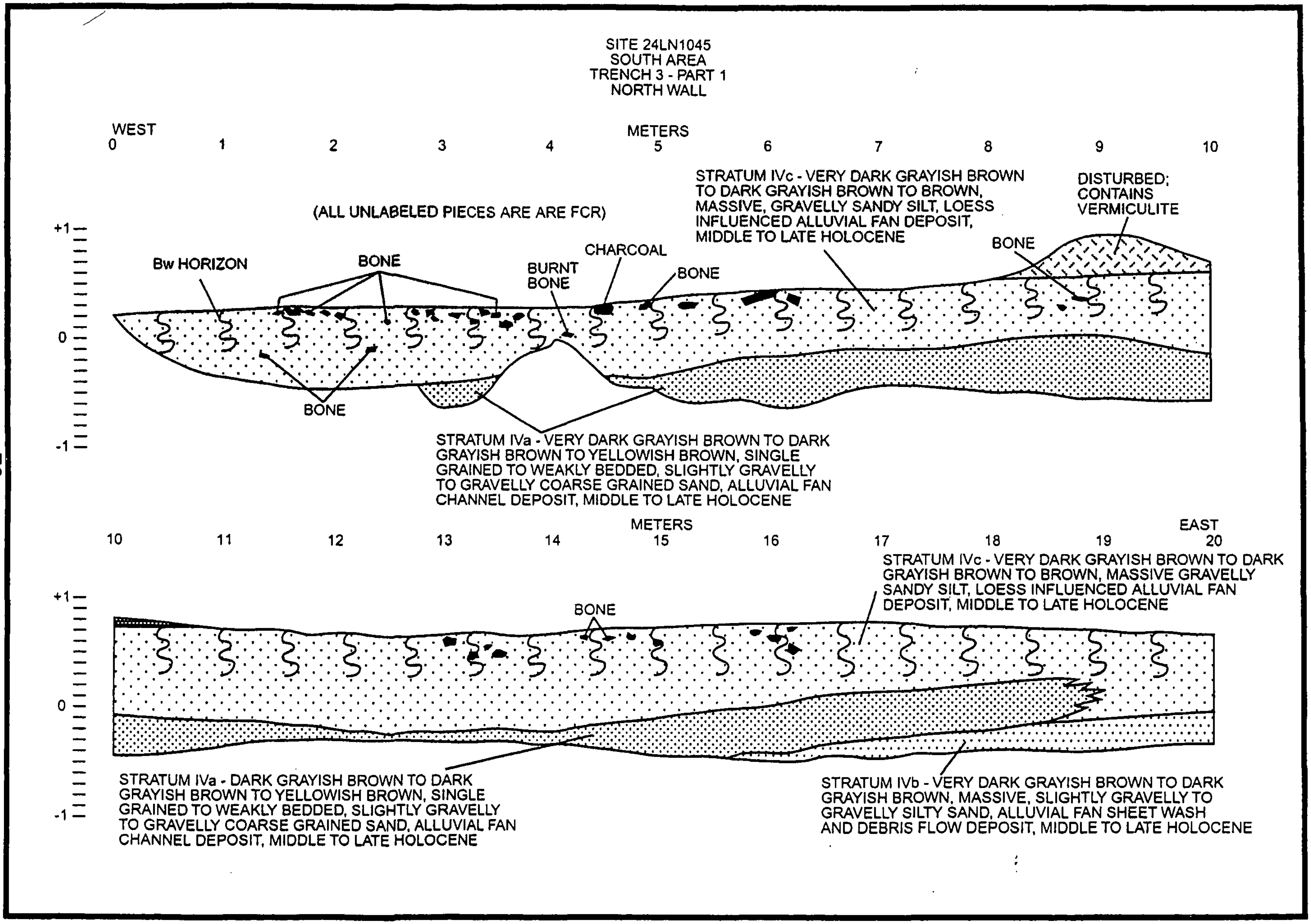


Figure 13: Profile of Trench 3, south area, site 24LN1045 (part 1).

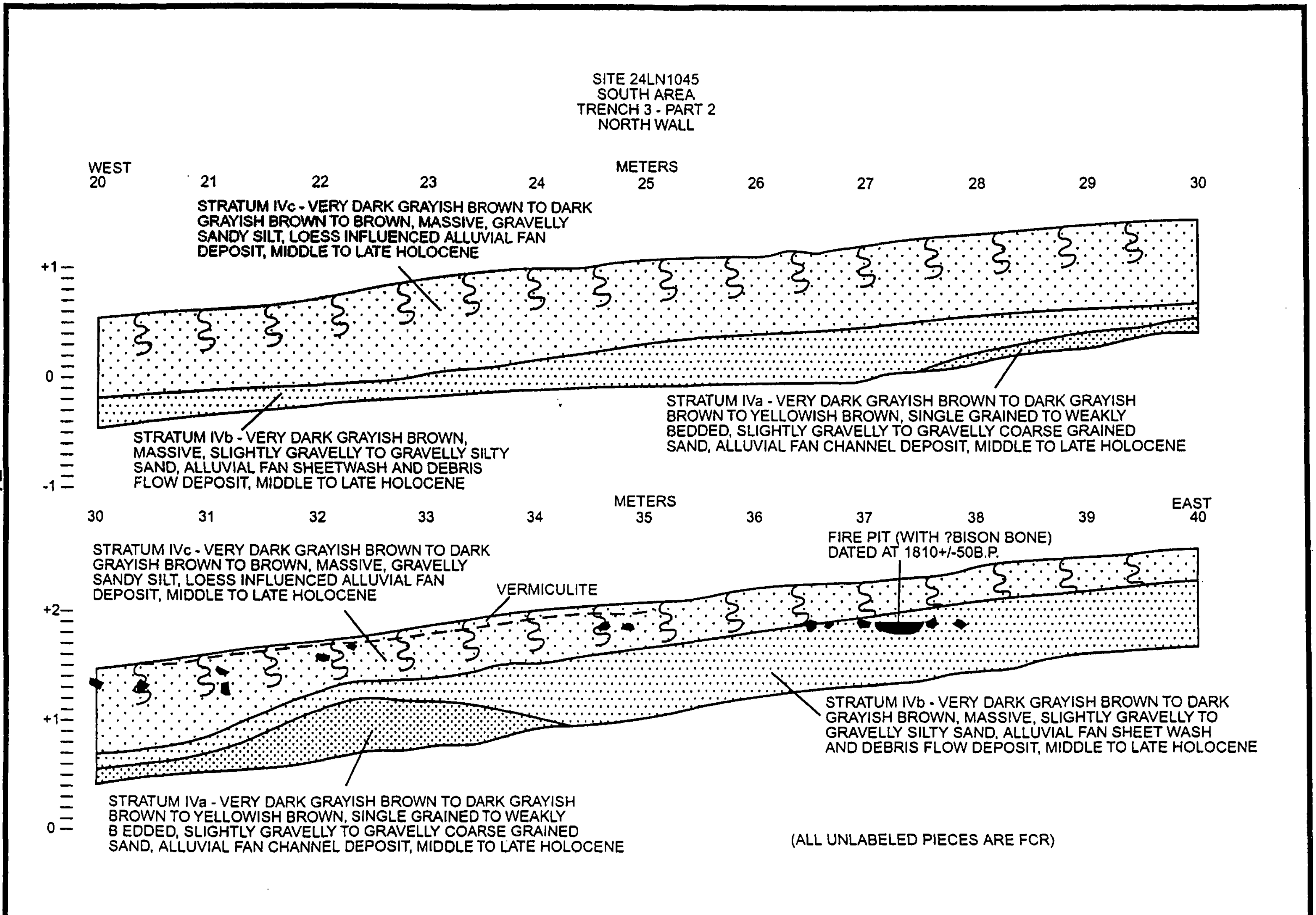


Figure 14: Profile of Trench 3, south area, site 24LN1045 (part 2).

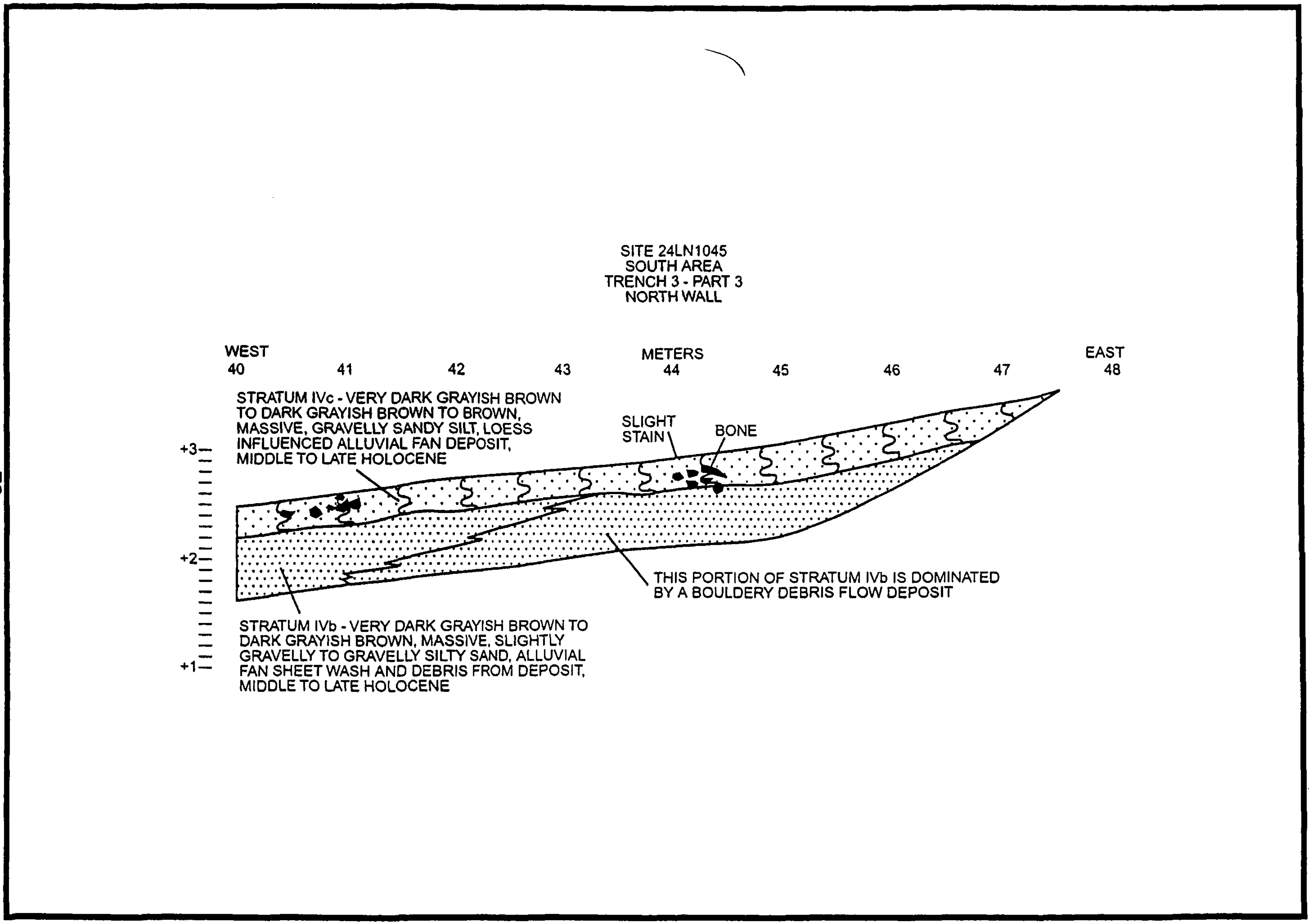


Figure 15: Profile of Trench 3, south area, site 24LN1045 (part 3).

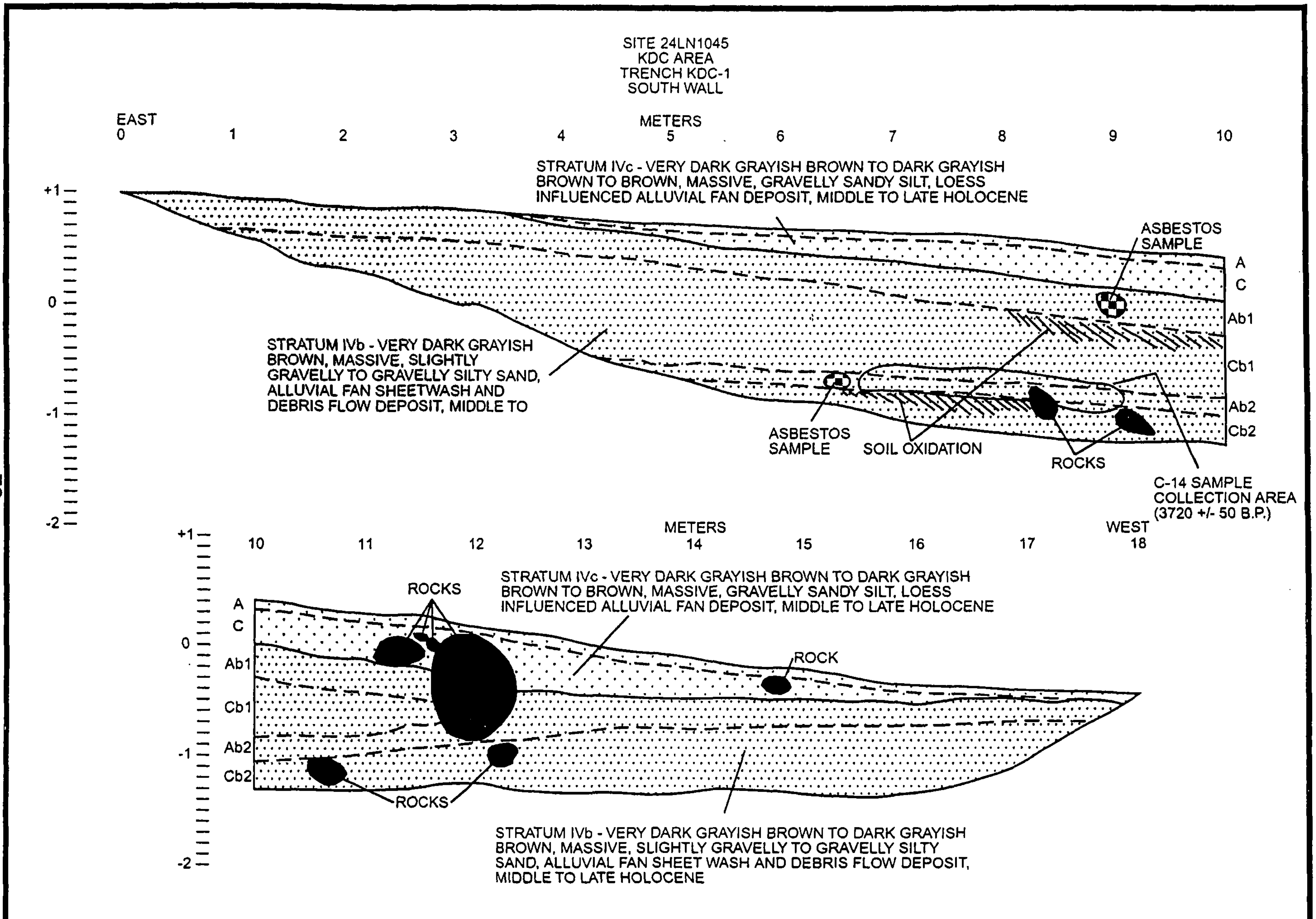


Figure 16: Profile of Trench KDC-1, south area, site 24LN1045.

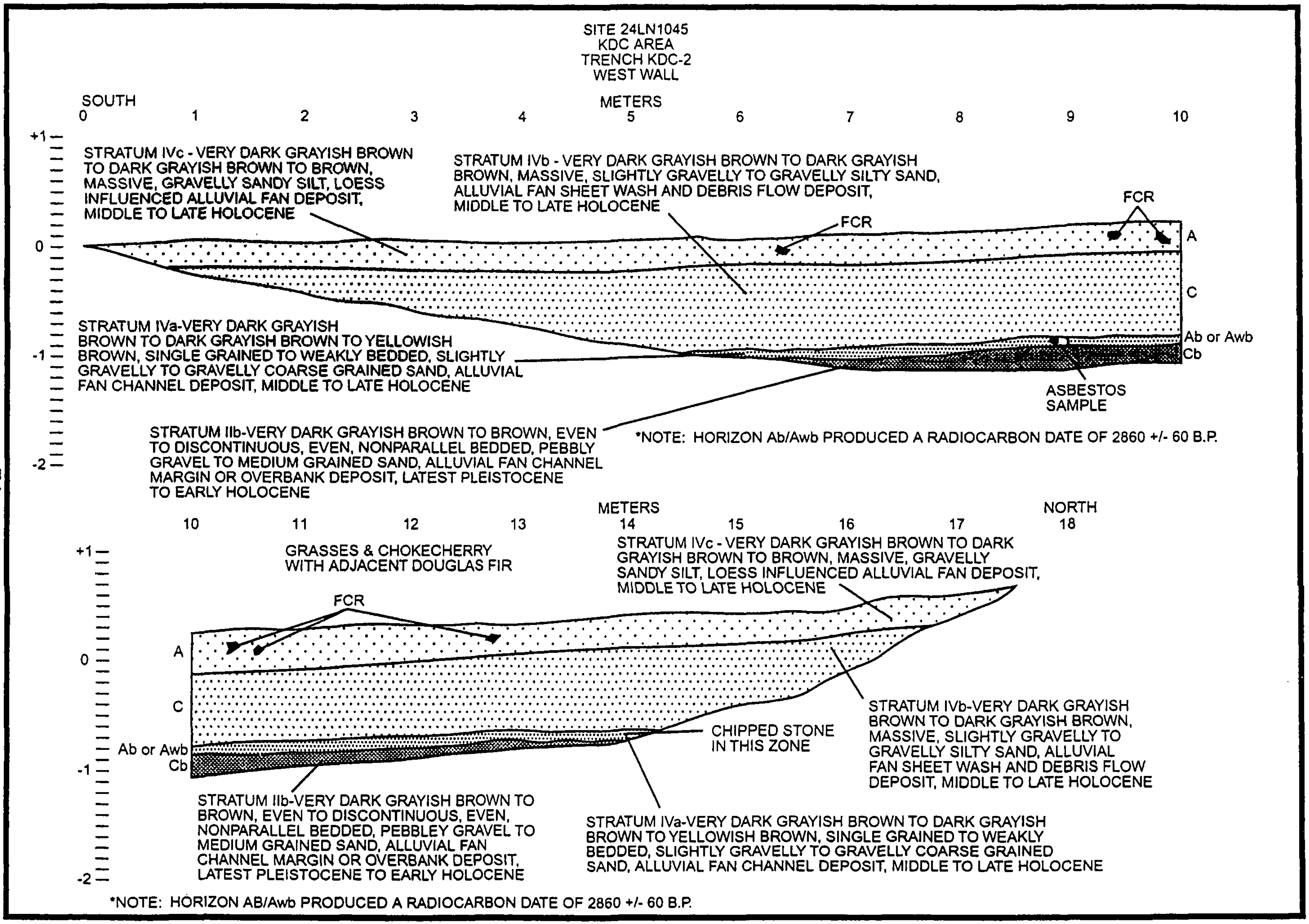


Figure 17: Profile of Trench KDC-2, south area, site 24LN1045.

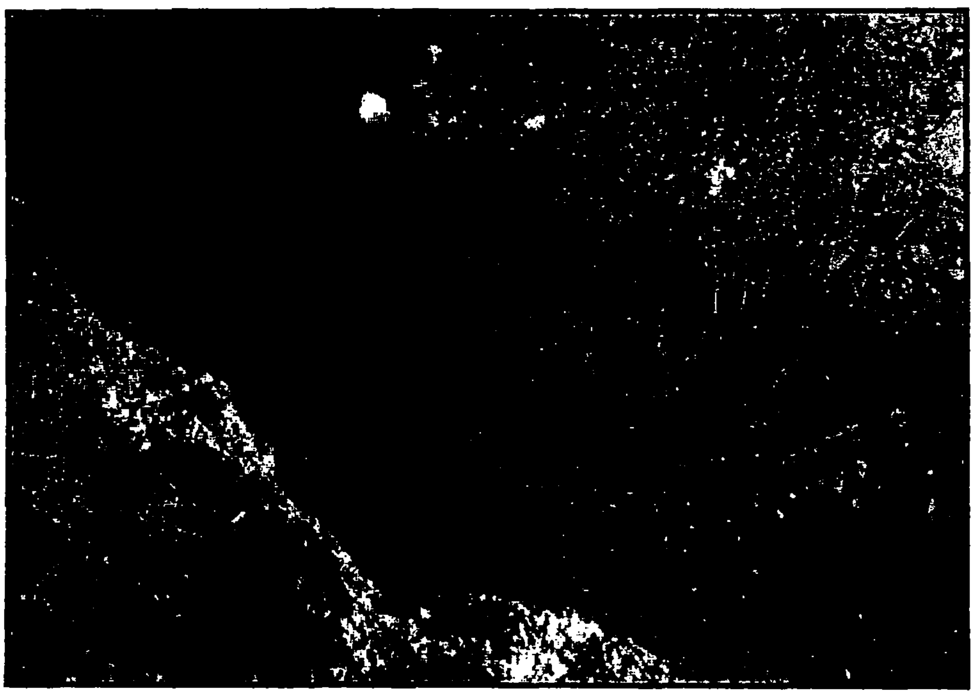


Figure 18: 24LN1045, Trench KDC-2 wall profile, looking northeast.

cmbs), a dark grayish brown, very fine sand. Structure of Bw3 is moderate, very coarse angular blocky. All three Bw horizons are characterized by their structure and (in some areas) presence of redder color or oxidation which do not quite meet field criteria for a cambic horizon. Horizons C1 (32-55 cmbs), C2 (55-90 cmbs), C3 (90-100 cmbs), and C4 (100-120 cmbs) are dark grayish brown and single grained. Texture of C1 and C2 is fine sand, whereas C3 is medium sand and C4 is gravelly medium sand. Very thin calcium carbonate is common on the bottoms of rocks in horizon C4, and is strongly effervescent upon application of dilute hydrochloric acid. The soil horizon-stratigraphic unit correlates are: Ap, Bw1, Bw2, and Bw3 = stratum Vd; C1 and C2 = stratum Vc; C3 = stratum Vb; and C4 = stratum Va. Soils characterized by oxidized Bw horizons also occur in Trench 3 of the KDC area (Figure 24), and Trenches 2 (Figures 25 and 26), 3 (Figures 13-15), and 6 (Figures 27 and 28) of the south area. This soil is classified as Typic Cryorthent

In Trench 3 (and Test Unit S-1) in the south area of the site, four soil horizons occur: A, AB, Bw, and Ck (Appendix A; Table 11). All horizons have gravelly sandy loam texture. Horizon A (0-7 cmbs) is dark grayish brown to very dark grayish brown, single grained, accumulation of minerals and organics, The lower boundary is clear and broken. It is underlain by horizon AB (7-20 cmbs), which is dark grayish brown to very dark grayish brown and single grained. Next is horizon Bw (20-70 cmbs), also dark grayish brown to very dark grayish brown in color. Structure in this Bw horizon is weak, medium subangular blocky, and oxidation is visible in some areas. The lowest horizon is Ck (70-90 cmbs), a grayish brown accumulation of diffuse calcium carbonate that is violently effervescent. Horizons A, AB, and Bw occur in stratum IVc, and horizon Ck is in stratum IVb. This soil is a Xerochrept or a Eutrochrept.

Site Formation and Destruction

Background

A discussion of pertinent site formation and destruction processes is presented here. The following categories are summarized, which generally follow (Gifford (1978): occupation trampling, post-occupational (preburial) dispersal, burial dispersal, and post-burial dispersal. The principles outlined here are used to evaluate the context of each occupation.

Occupation Trampling

The magnitude of occupation trampling (treading and scuffing) varies with respect to substrate texture, occupation traffic intensity (Schiffer 1987), and moisture content (Deal 1985). Experimental studies indicate that an occupation "churn zone" is formed in loose substrates. Well sorted sands produce the thickest churn, or trample, zone that ranges from 5-16 cm in thickness (Appendix A; Table 1) (Gifford-Gonzalez et al. 1985; Stockton 1973). Loamy sand will develop a 3-8 cm trample zone (Villa and Courtin 1983), whereas loams produce "almost no" churn zone (Gifford-Gonzalez et al. 1985). Clayey sediments, likewise, require extremely high levels of traffic or saturation before any churn zone is produced (Eckerle unpublished field observations). Pedestrian traffic on cobble or larger size clasts will not produce a trample zone at all (Hughes and Lampert 1977).

Trample zones can be viewed as both a positive and a negative aspect of site formation. Churn zone development on a soft substrate has the effect of blurring the occupational record of stratified sites (Hughes and Lampert 1977; Villa 1982). The positive aspect of churn zones is

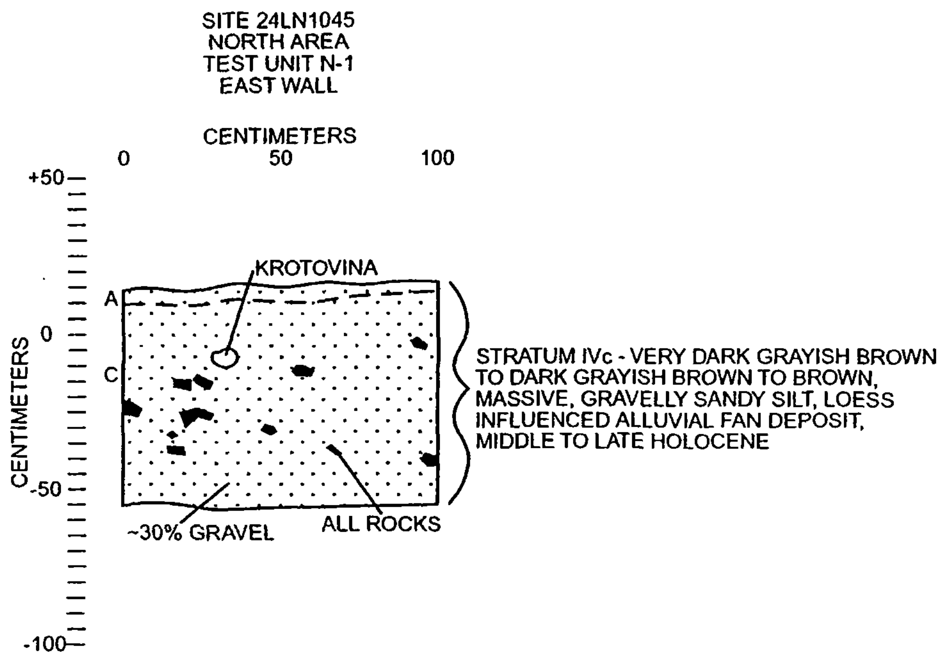


Figure 19: Profile of Test Unit N-1, north area, site 24LN1045.

Figure 20: 24LN1045, XU: N-1, east wall profile, looking east.

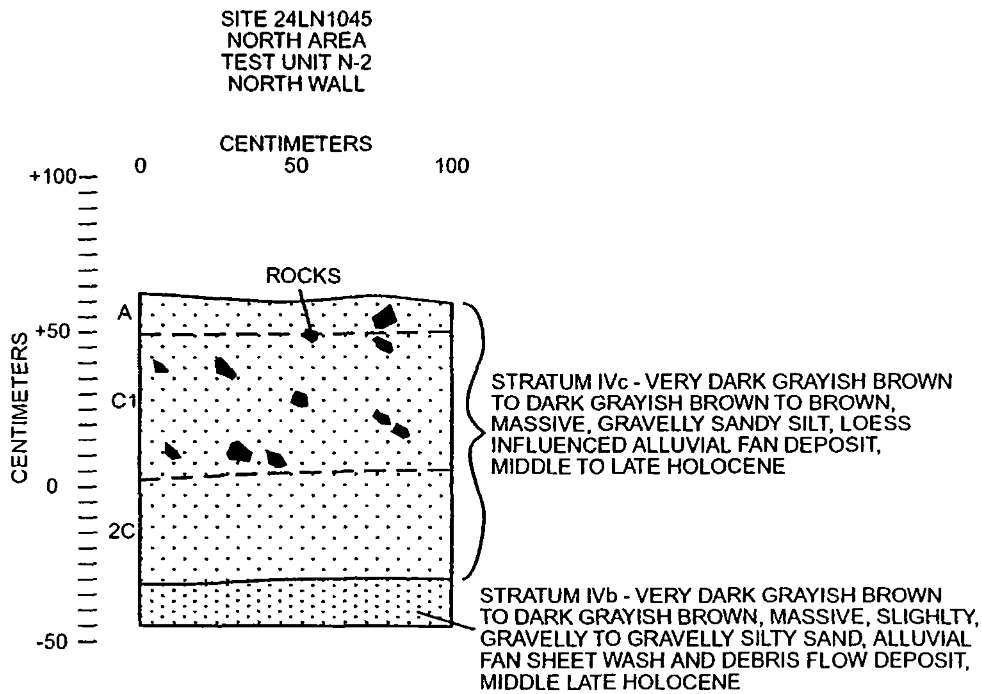


Figure 21: Profile of Test Unit N-2, north area, site 24LN1045.

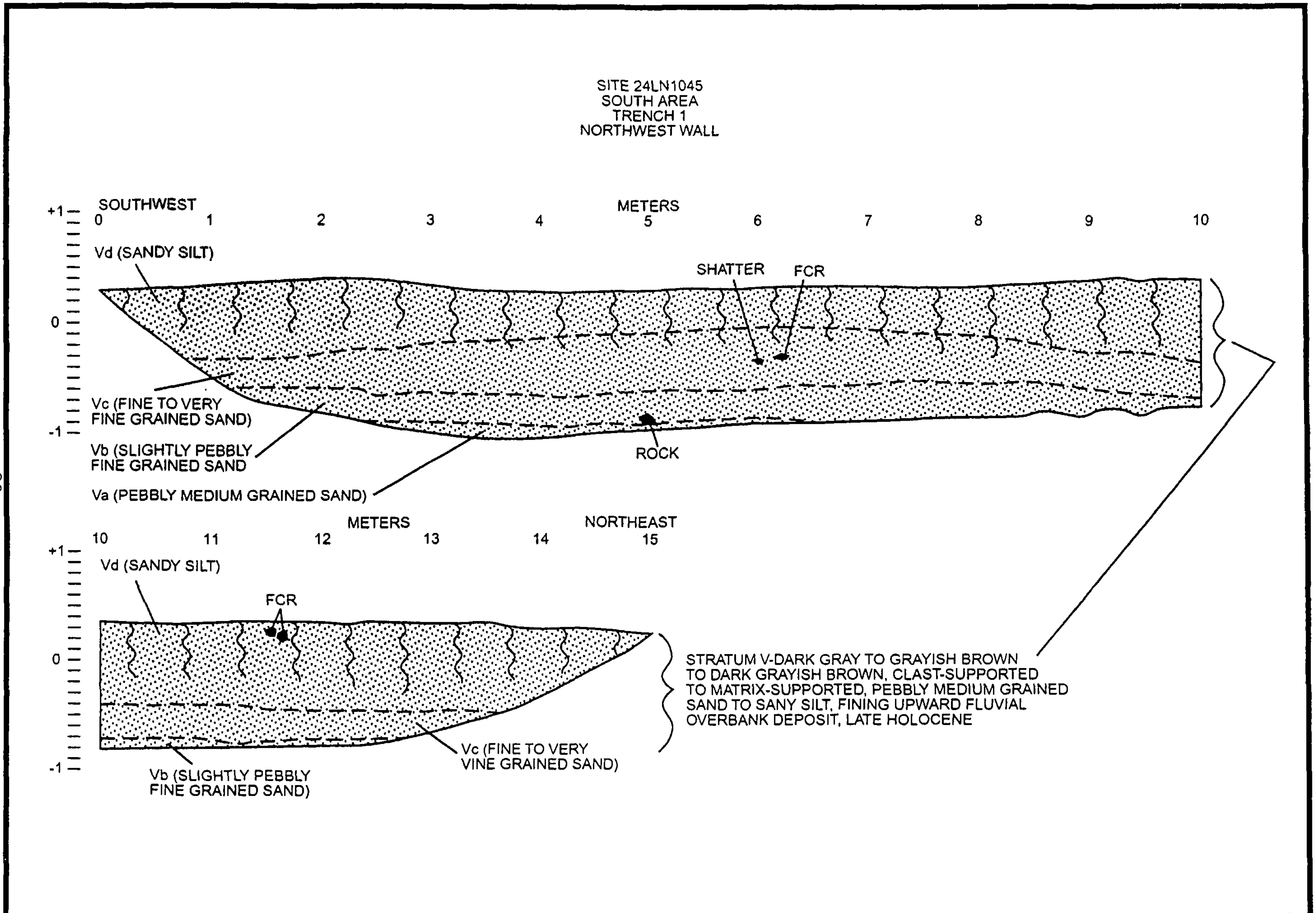


Figure 22: Profile of Trench 1, south area, site 24LN1045.

Figure 23: 24LN1045, Trench 1, view east, showing overbank sediments on disturbed T1 terrace.

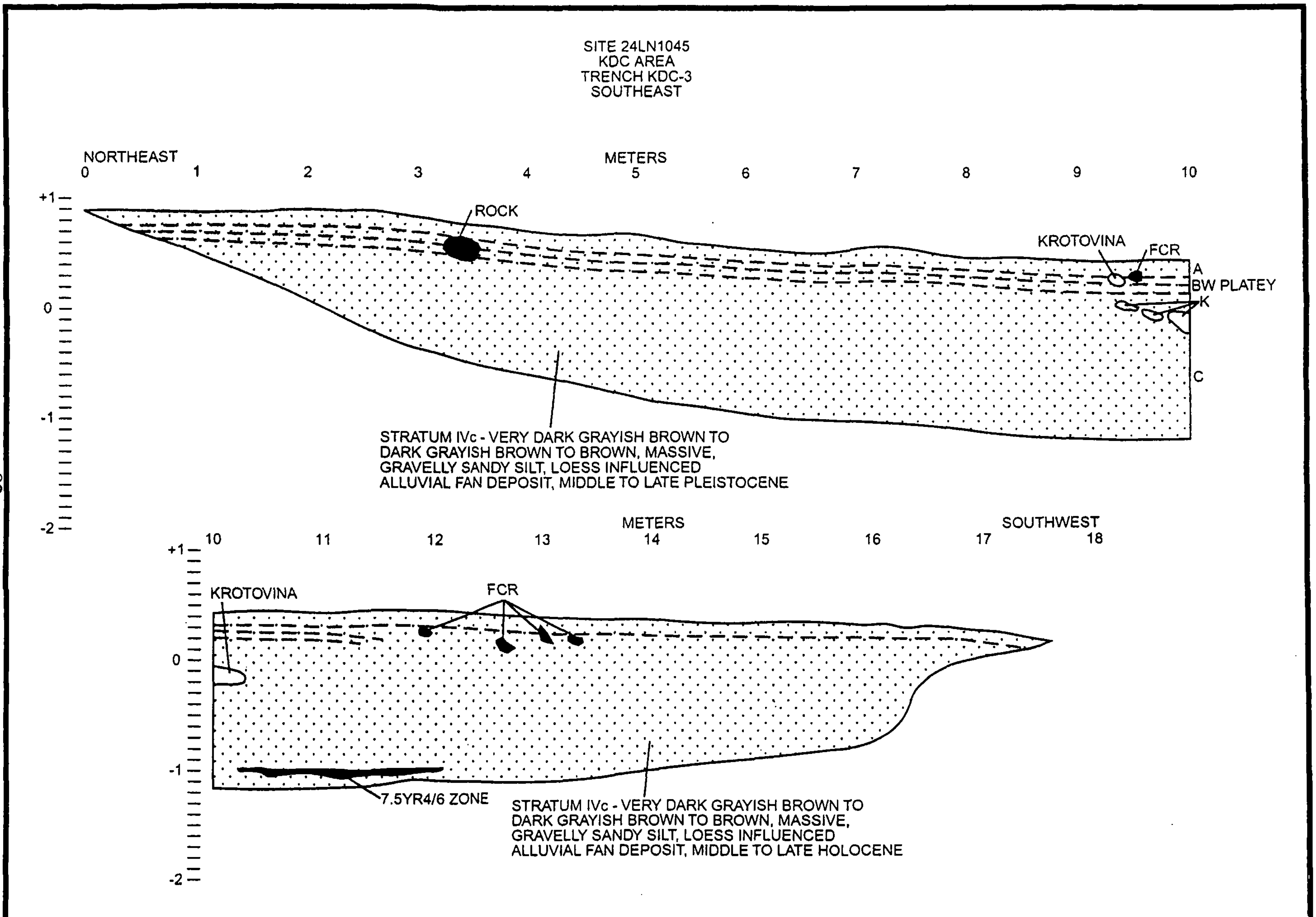


Figure 24: Profile of Trench KDC-3, south area, site 24LN1045.

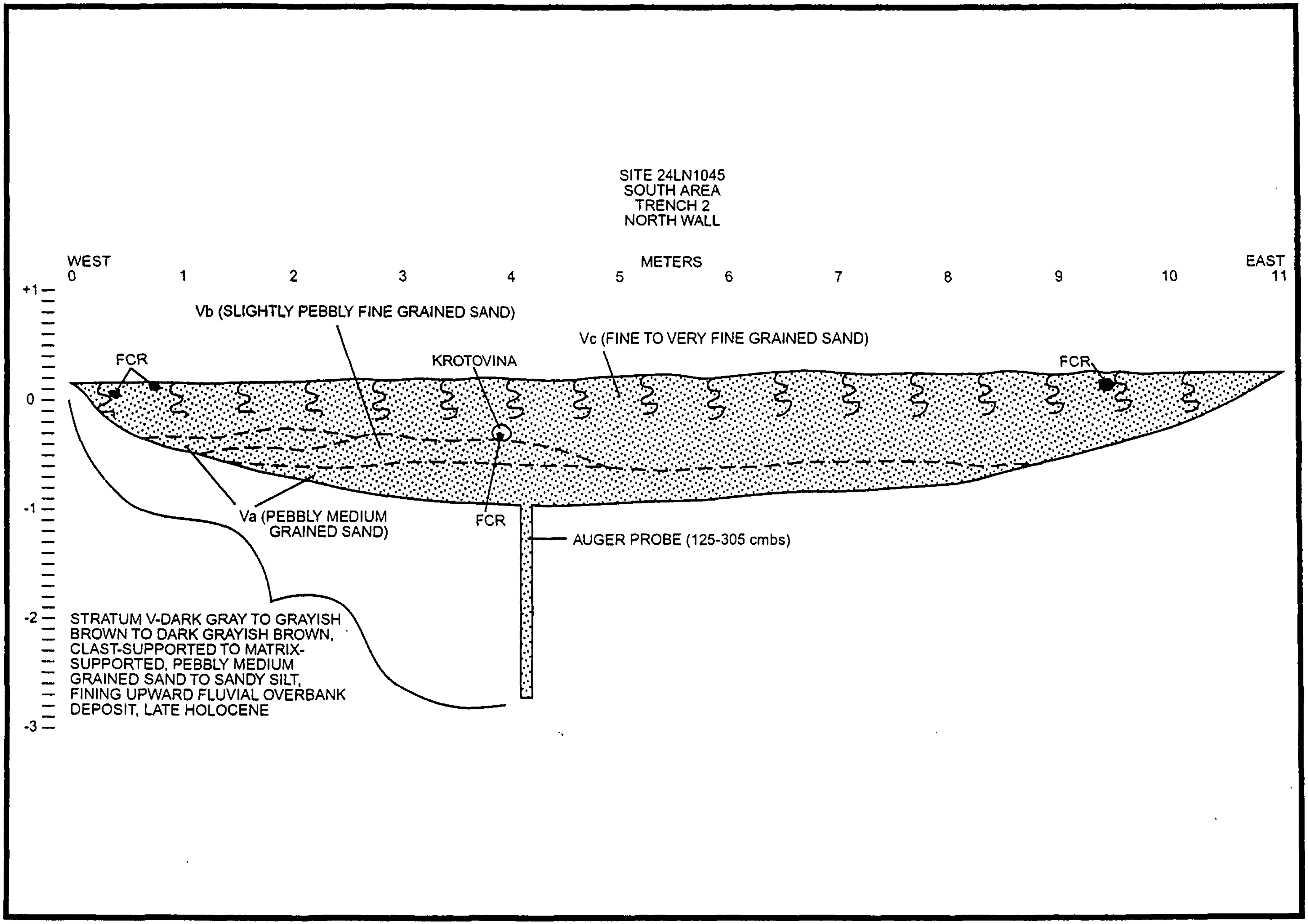


Figure 25: Profile of Trench 2, south area, site 24LN1045.

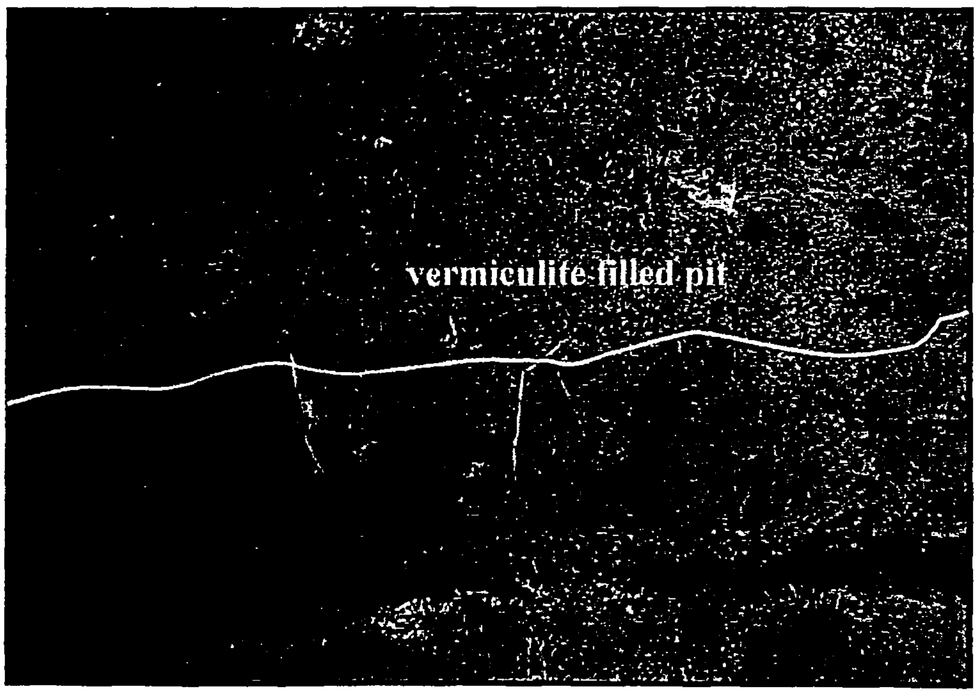


Figure 26: 24LN1045, Trench #2 profile with vermiculite, looking southeast.

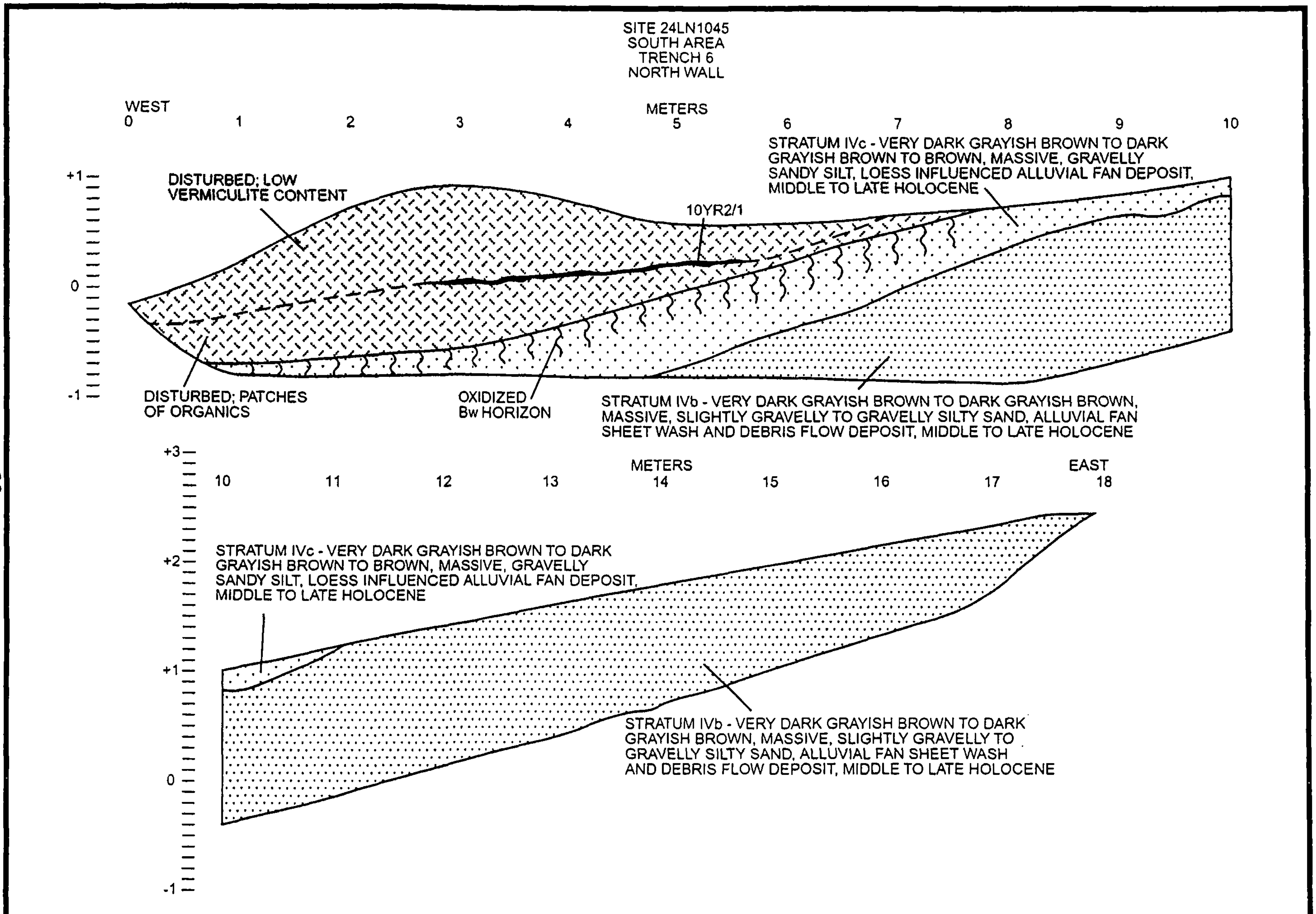


Figure 27: Profile of Tench 6, south area, site 24LN1045.

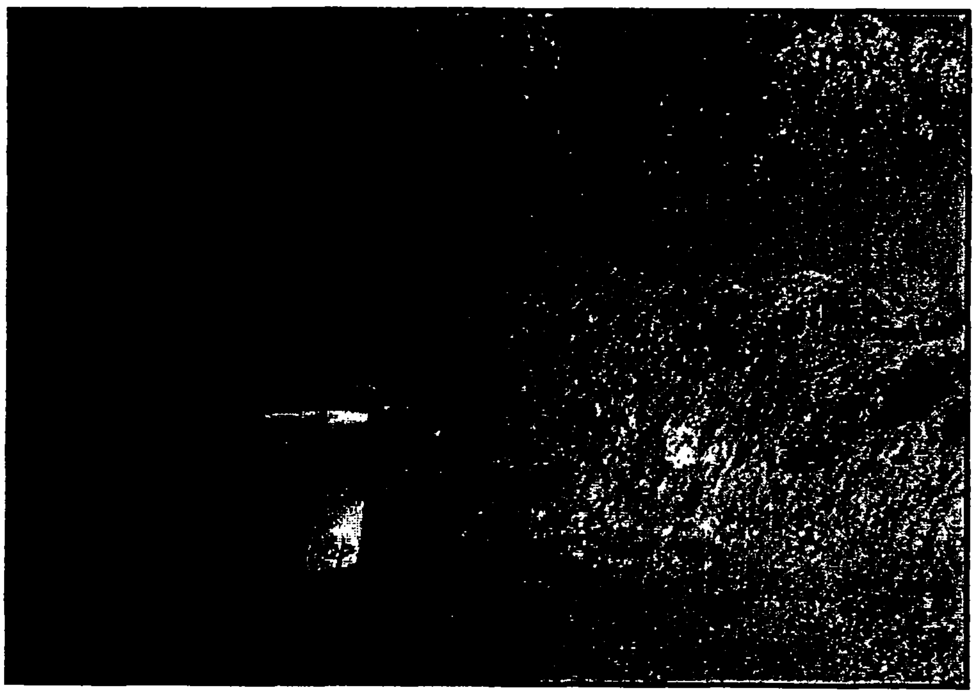


Figure 28: 24LN1045, south side Trench 6.

that their formation quickly hides artifacts and makes them unavailable for site cleaning and secondary refuse disposal (Schiffer 1987). In addition, items are much easier to lose in soft substrates (Schiffer 1987). As a result, there is a higher potential for discriminating areas of high primary-discard (lodges, hearth activity areas, etc.) from those of low primary-discard in soft substrates. Additionally, scuffage (horizontal artifact dispersal due to foot traffic) is minimal on loose substrates because items are less likely to skid.

Post-Occupational Dispersal

Post-occupational (but preburial) dispersal can alter the contextual integrity of surface archaeological materials. In general, soft substrates tend to hold onto artifacts after they have settled into the surface (Wandsnider 1988). Additional trampling by animals, slope processes, and eolian movement are the major categories of post-occupational dispersal. However, trampling by animals, even in environments with high populations of hoofed ungulates, is a slow process (Gifford and Behrensmeyer 1976).

Slope wash and colluviation are two common processes that transport surface artifacts. The process of colluviation occurs commonly on relatively steep (>15^{o}) slopes (Rick 1976). Colluviation is gravity driven transport in which heavier and denser materials move farther down slope than lighter, less dense items (Rick 1976). Slope wash, on the other hand, involves transport in a sheetflow layer of water during storms (Butzer 1982; Reineck and Singh 1980). It can occur on low angle slopes, especially if vegetation is sparse and infiltration levels are low. This type of transport follows hydrodynamic rules in that smaller, less dense material, is transported the farthest down slope.

Eolian transport of surface artifacts can occur whenever windshear exceeds the hold of gravity (Bagnold 1941). This can be a major source of dispersal for small artifacts unless they quickly become buried (Wandsnider 1988). Eolian transport is not confined to dune fields but can occur whenever wind conditions are suitable. It is most effective on locations with minimal vegetation cover.

Burial Dispersal

Artifact dispersal occurs in most depositional environments (Butzer 1982). An exception to this is eolian silt (loess) environments. Lack of dispersal in loess is the result of a low surface wind shear (because vegetation is usually present) and low impact energy of silt particles. Many surface sites on flat, vegetated surfaces are eventually, albeit slowly, buried by silt. Other depositional environments can be ranked into two categories of potential burial dispersal. The relatively low energy category includes alluvial overbank, sheetflow (including slope wash), and eolian sand environments. The high energy category includes alluvial channel, debris flow, and colluvial depositional environments. For most water and air entrained sediments, artifact movement is a function of size and density (Gifford and Behrensmeyer 1976). Frison et al. (1988) propose a simple rule-of-thumb for determining the depositional dispersal of buried lithic artifacts. This rule states that any artifacts smaller than the break off point for the coarsest 10% of a sediment sample (finer than the 90th percentile) were probably moved during burial.

Post-Burial Dispersal

A wide range of processes can act to disperse archaeological residues after burial. Erosion and subsequent redeposition can produce a secondary deposit that contains no contextual integrity (Butzer 1982; Schiffer 1987). Many other dispersal processes are possible (Butzer 1982; Schiffer 1987; Wood and Johnson 1978), including soil formation, fauna burrowing, plant growth (including tree tip-out), and turbation from repeated ground freezing (frost heave).

Analysis of Natural and Cultural Stratigraphic Context

All cultural material at site 24LN1045 occurs in deposits that appear to be above stratum III. Stratum III contains volcanic ash suspected to be from the eruptions of Mount Mazama in the middle Holocene around 6845 B.P. (see Figs. 12, 13, and 29). Chipped stone, butchered bone, heat-altered rock (or fire-cracked rock), and sometimes charcoal frequently occur in the uppermost 10 cm in the south area of the site, especially in Trenches 3 (Figures 13-15), 4 (Figure 30), and 5 (Figure 29). Cultural material also occurs at depth [(50-65 cmbs) e.g. Figs. 22, 23, 31 and 32]. All remains are either in alluvial fan deposits (stratum IV; Figure 33) or fluvial overbank sediments (stratum V; Figures 34 and 35).

The sediments of stratum IV were emplaced in a variable, but generally high energy alluvial fan depositional environment, and consist of trace/slightly gravelly to gravelly silty sand and sandy silt. Given the depositional energy regime of this unit, there is variable likelihood for preserving spatial-behavioral context, with the best context being in the trace pebbly deposits. Conversely, cultural material in stratum V is contained in sand and sandy silt deposited by fluvial overbank processes in a low to moderate energy regime, better for preserving context.

The depositional history of stratum IV implies that most cultural material was probably not buried in situ. Stratigraphic context, if present, would have been further degraded by effects of slope and tree tip-out processes, as well as cryoturbation. Cultural materials within stratum V had a better chance of retaining their stratigraphic context during deposition, but have likely also been affected by slope and turbation processes. Unfortunately, no distinct occupation zones were noted in stratum V. A lack of stratigraphic context in stratum VI suggests that individual occupations have not been sealed as discrete grouping of same-age assemblages with preserved spatial-behavioral relationships. The quality of the cultural spatial-behavioral context is predicted to have been moderate for stratum V, and poor for stratum IV.

Paleoenvironmental Reconstruction

During the Pleistocene, a lobe of continental ice extended south and covered the project area. As deglaciation ensued, ice remained in the Purcell Trench (Idaho) forming Glacial Lake Kootenai in the Kootenai River valley and resulting in lake sediment deposition. After breaching of the ice dam and draining of the lake, valley downcutting began and was followed by deposition of the sediments comprising higher terraces observable today along some stretches of the Kootenai River (e.g. T4 and T3). The recently glaciated terrain lacked vegetation, resulting in significant sediment availability. Transport of this sediment was facilitated by meltwater flowing down the Kootenai River valley and its tributaries. Alluvial fans formed at the mouths of these tributaries, including Rainy Creek, during the latest Pleistocene and into the Holocene (strata I-IV). Valley incision continued as the fan prograded out into the valley. Based on the position of the Mount Mazama ash in the alluvial fan sediments, the majority of the Rainy Creek

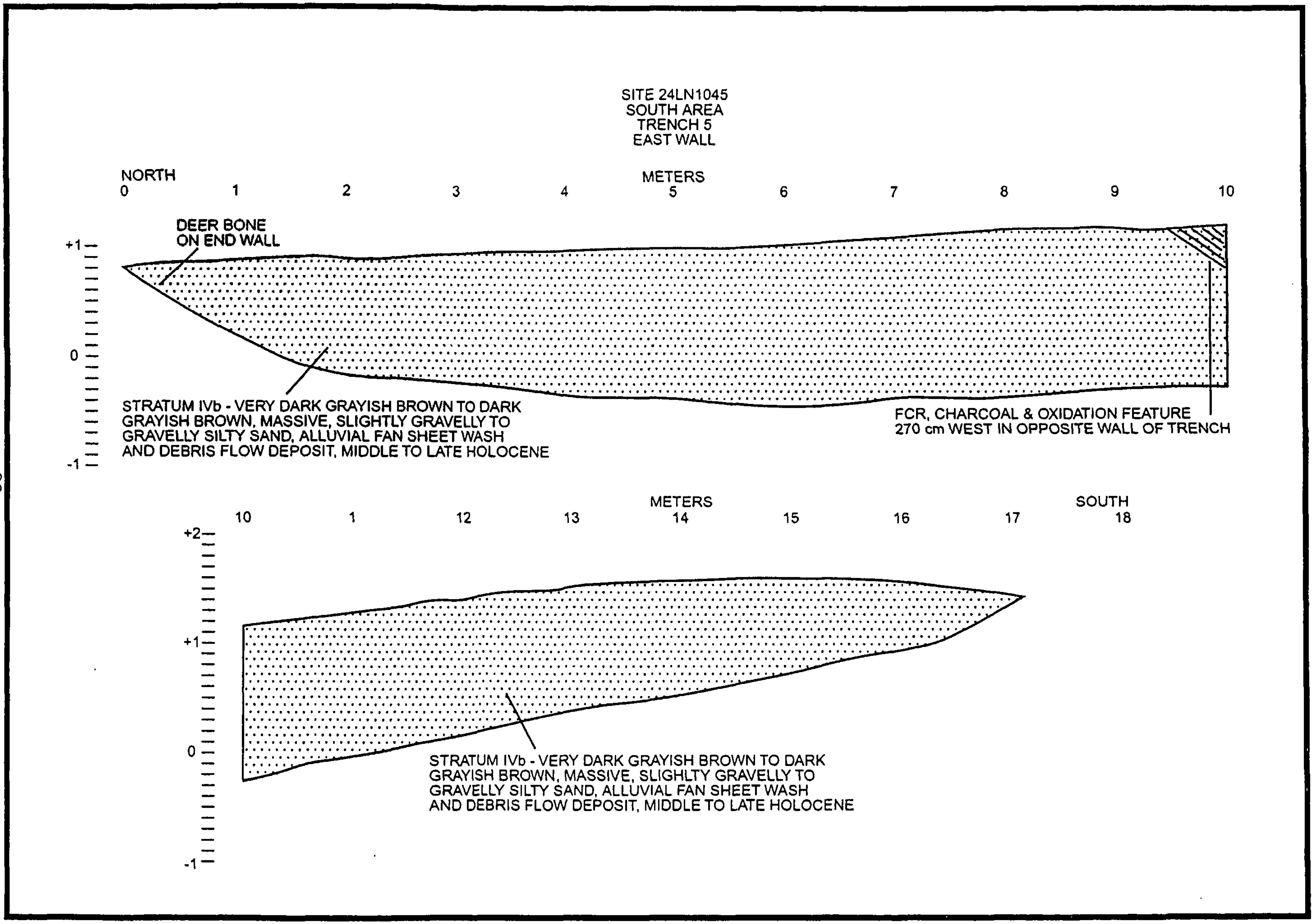


Figure 29: Profile of Trench 5, south area, site 24LN1045.

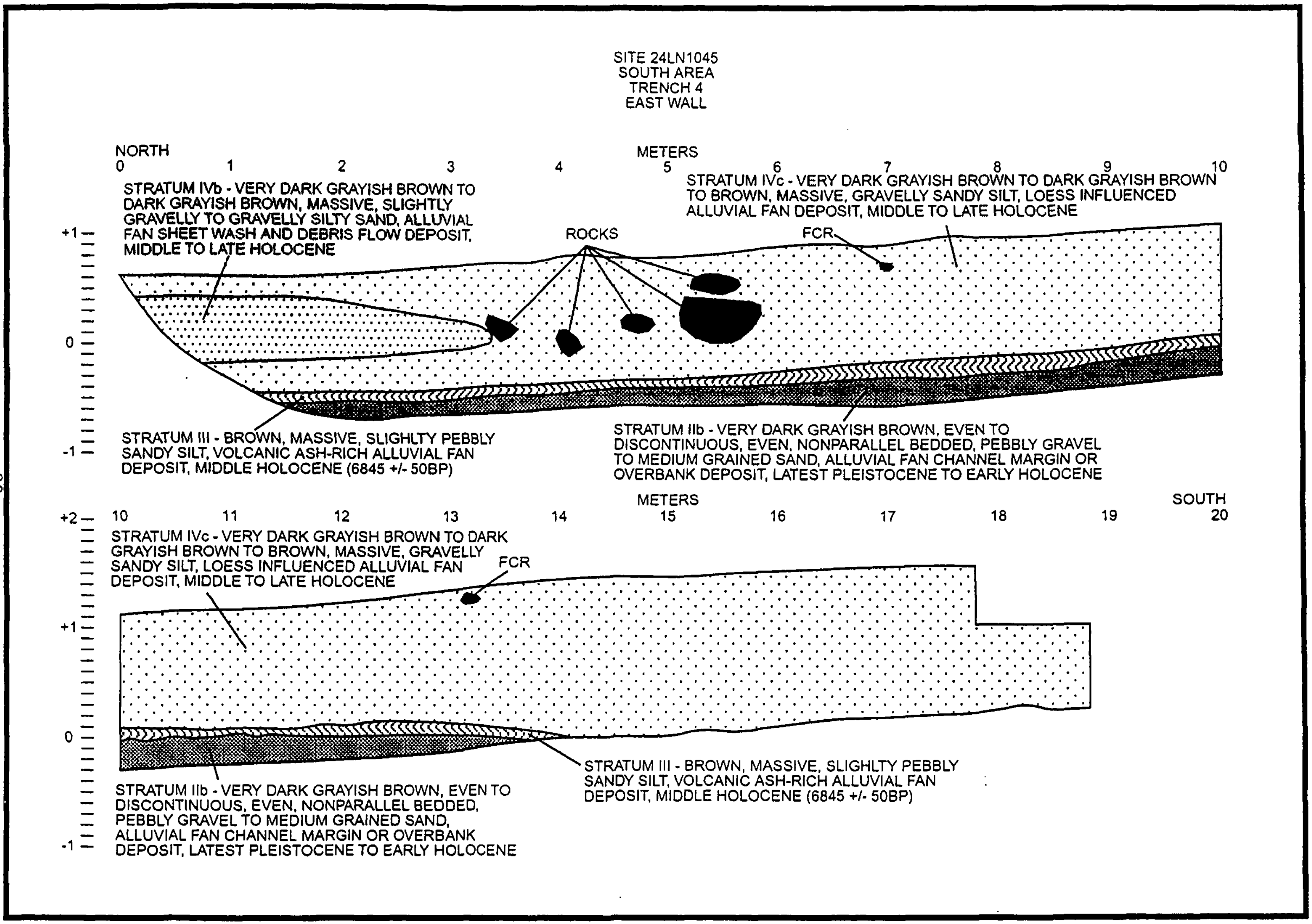


Figure 30: Profile of Trench 4, south area, site 24LN1045.

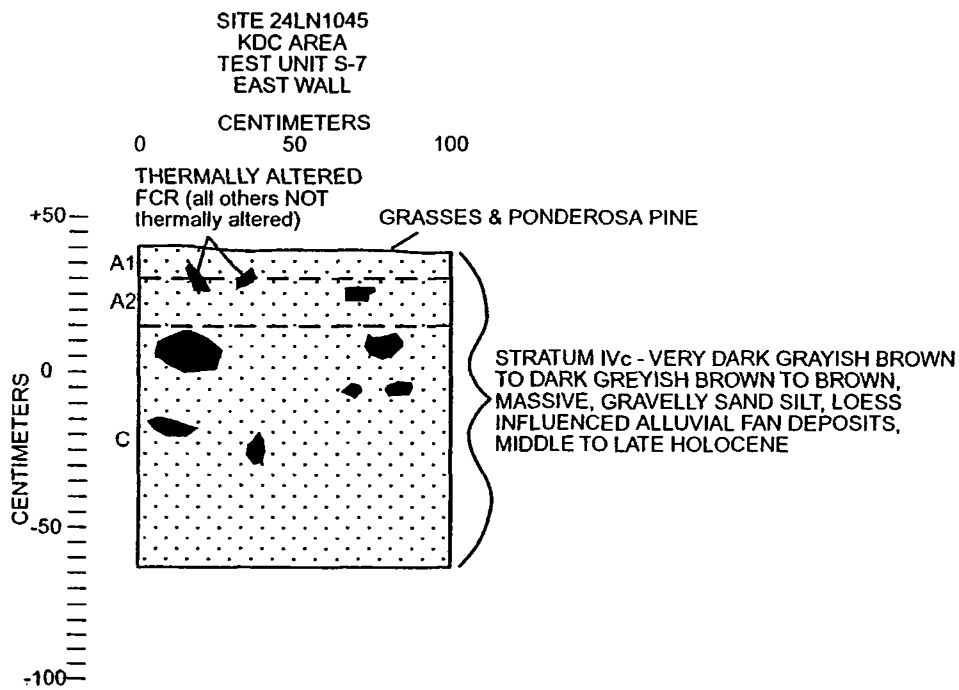


Figure 31: Profile of Test Unit S-7, south area, site 24LN1045.

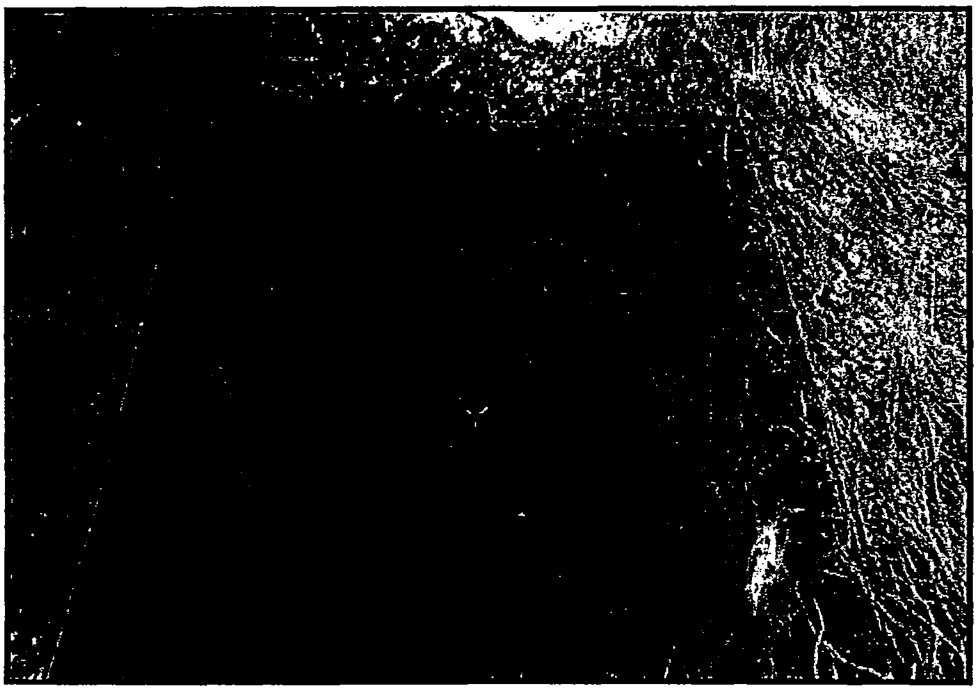


Figure 32: 24LN1045, XU: S-7, west wall profile, looking west.

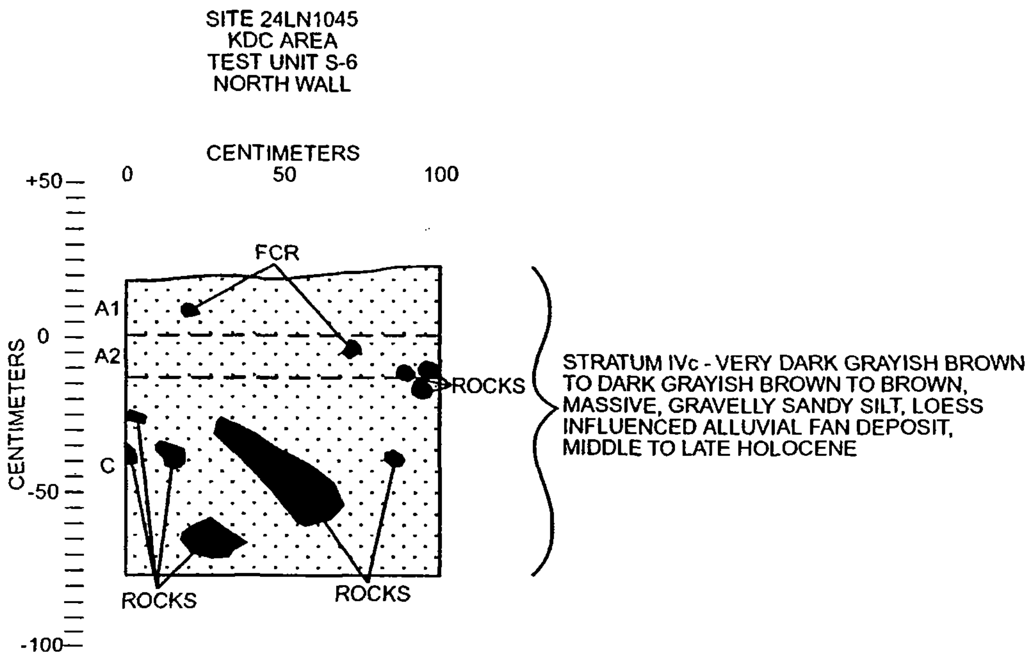


Figure 33: Profile of Test Unit S-6, KDC area, site 24LN1045.

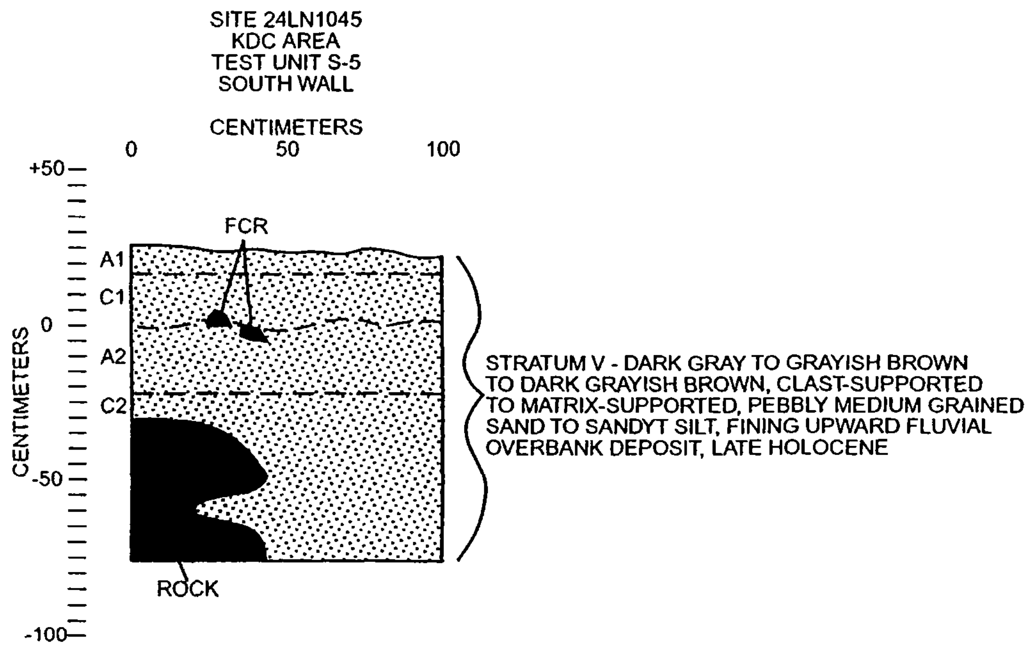


Figure 34: Profile of Test Unit S-5, KDC area, site 24LN1045.

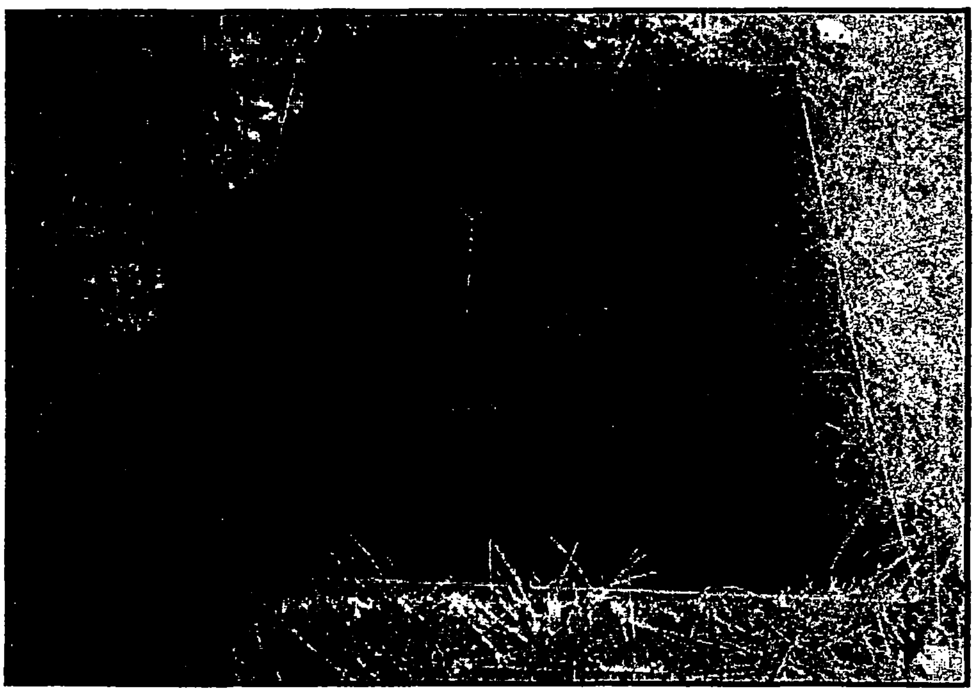


Figure 35: 24LN1045, XU: S-5, east wall profile, looking east, showing T1 overbank sediments overlying boulders.

fan was deposited before the middle Holocene (i.e. ~6845 B.P.). During the early deglacial era, sediment would have been readily available for fan formation as vegetation needed time to reestablish itself in the area. However, after floral re-colonization, significant alluvial fan deposition would have mainly occurred during relatively arid periods. Aggradation on the fan continued with debris flow, sheet wash (stratum IV), and fluvial overbank (stratum V) deposition during site occupation in the late Holocene. Organic paleosols (~3720 and ~2860 B.P.) may reflect relatively moister conditions, whereas the oxidized surface soil probably reflects drier conditions. The toe of the fan was eroded into a scarp some time in the late Holocene, and two fluvial terraces (T2 and T1) formed against the scarp as valley downcutting continued.

CULTURE HISTORY

by
Stephen A. Aaberg and Kristin Griffin

Prehistory

Organizing Concepts for Archaeological Information/Prehistory

Two concepts used for organizing archeological information are the culture area and the cultural chronology. A culture area is a physiographic division with unique sets of environmental conditions, where human groups, in adapting to those conditions, have developed more traits (e.g. languages, social institutions, technologies) in common with each other than with groups outside the area.

Cultural chronologies chart change in human groups over time, by ordering traits in sequence as they appear in the archeological record. Cultural traits of past human groups that survive in the archeological record are limited to material objects (artifacts) people left behind. Morphological similarities in artifacts are considered by archeologists to correspond with similarities in other aspects of culture. Thus, artifacts can be viewed as expressions of relatedness or divergence between human groups across space, and thus can be used as markers of cultural change through time.

Most cultural chronologies are based on those classes of artifacts most prominent in the archeological record. Not only are these artifacts most readily studied, but they are also assumed to represent those activities and behaviors that were of central importance to the people who made them. In assemblages of archaeological material associated with hunter-gatherer groups, projectile points are most often used as indices of change. Culture chronologies for these groups are often based on morphological differences between projectile points that are found consistently at different periods in the archeological record.

An example of a Plains area culture chronology based on projectile point types is one developed initially by Mulloy (1958) and further refined and revised by Reeves (1983) and Frison (1991). For instance, points identified by archeologists with the name "Folsom" (after the type site in New Mexico) have been found consistently in the archeological record in contexts radiocarbon dated to around 9000 B.C. Wherever points matching the Folsom style are found, they are seen as representing human habitation dating to that period, and conforming (more or less) to a "Folsom lifestyle". In the Mulloy/Reeves/Frison scheme, Folsom is one of the earliest in a sequence of Plains area cultural periods, named for projectile points.

Some projectile point types appear in disparate settings over broad geographic areas. For instance Clovis points, made by the earliest human inhabitants of the New World, are found throughout North America and extend into Central America. Other types differ only in minor ways from points in adjacent areas. In spite of the fact that certain artifact classes may be widely distributed, culture chronologies, whether based on projectile points or not, are often defined from assemblages, or portions of assemblages, of archaeological material found within particular culture areas.

Culture Area and Culture Chronology Concepts Applied to Archaeology of the Kootenai River Area of Montana

Archeological study was a relative late-comer to northwest Montana. The accumulation of archeological information was outpaced by the compulsion of archeologists to organize it. Various prehistoric cultural chronologies have been developed for northwestern Montana, but most of these are based primarily from work in other regions and are not entirely applicable to the project area (Malouf 1956a, 1956b; Reeves 1972; Choquette and Holstein 1980; Roll 1982; Choquette 1984; Thoms 1984; Thoms and Burtchard 1987). The proliferation of locally based chronologies and the lack of a broad based prehistoric framework for Northwestern Montana and the Northern Rocky Mountain region has created some confusion in comparative studies of regional archaeology. Attempts to impose cultural chronologies from outlying regions, such as the Columbia Plateau and Northern Plains, are not always successful due to the distinct nature of prehistoric archaeological sites, cultural materials, and subsistence regimes in the Rocky Mountain region of Western Montana. The Kootenai area, in particular, has not fit neatly into existing cultural chronologies developed for adjacent regions.

The need to examine the Rocky Mountain Region, and specifically western Montana as a distinct archaeological culture area was recognized very early by Malouf (1956a and 1956b). Recently, the Rocky Mountain area was formally recognized as a distinct cultural region, worthy of recognition and refinement of archaeological data, by the professional archaeological community. The first meeting of the Rocky Mountain Anthropology Conference was held in Jackson, Wyoming in 1993. The problem of establishing a regional cultural chronology for distinct geographic units within the Rocky Mountains was recognized as a primary goal for the future.

Kootenai Canyon Culture Locality in the Plateau Culture Area

Northwest Montana is considered by some to be part of the Plateau Culture area. However, northwest Montana differs from the rest of the Plateau in ways that likely had significant implications for the human groups that inhabited the area.

One way archeologists cope with differences internal to culture areas is to identify subareas. Malouf (1956b) defined the Montana Western Region of the Plateau in terms of its mountainous topography and associated climatic and vegetational conditions.

Roll's (1982) Barrier Falls Subarea roughly corresponds to Malouf's Montana Western Region. However, Roll used major drainage divisions with their available resources as the defining factor for subareas. The Barrier Falls Subarea is that portion of the Northern Plateau encompassing the Kootenai River drainage upstream from falls in British Columbia and Idaho which block the migration of anadromous fish (Roll 1982:1.11). It is the absence of anadromous fish and other resources such as camas, caribou, and bison, which distinguishes the Barrier Falls Subarea from surrounding areas where these resources were central to human subsistence.

Researchers in Northwestern Montana have long recognized the differences between the Kootenai area and the rest of the Plateau in terms of natural environments and the adaptation of human cultures to those environments. This recognition has prompted some to identify subareas and regions within the Plateau where internal conditions have given rise to unique cultural adaptations.

Physiography of the Barrier Falls subarea, situated on the western slopes of the Rockies, is characterized by mountains and intermountain valleys. In Roll's scheme, the major drainage valleys constitute regions within the subarea, with the Kootenai Region being the most ruggedly mountainous. Roll identifies three localities along the river in the Kootenai region that are geographically distinct from each other. Therefore, these regions may have had distinct and internally consistent patterns of human adaptation, an assumption to be tested against the archeological record.

The Valley, Canyon, and Lake localities of the Kootenai region are conceived of as archaeological entities, but also roughly correspond to the linguistic and ethnic divisions identified for the Kutenai, the historic native inhabitants of the area (Roll 1982:1.18).

Kootenai Canyon Culture Chronology

As opposed to the Plains and much of the Plateau, Northwestern Montana did not receive concentrated archeological study until relatively recently. Intensive, systematic study of the Kootenai River area, with two exceptions, did not begin until the late 1960s and 1970s (Shiner 1950; Borden 1956; Taylor 1973, 1969, 1968; Jermann and Aaberg 1976; Roll 1979; Roll and Bailey 1979). When archeologists began to focus attention on northwest Montana, they found a lack of sites with stratigraphically segregated archeological deposits. Sites also displayed a paucity of material that could be reliably radiocarbon dated. With so little local information available as an internal data base, researchers resorted to ordering human prehistory in the area using cultural chronologies developed in the more intensively studied, and therefore, better-understood Plains and Plateau areas.

While applicable in a broad sense to adjacent areas, chronologies for the Plains and Plateau outline trends in adaptive strategies that are, in detail, unique to the internal environmental conditions and resource bases of those areas. One problem inherent in the application of externally derived culture histories is that cultural systems and traits come to be viewed primarily in terms of how they might have been influenced from the outside, rather than being viewed as responses unique to the local environmental conditions.

Laurd Project Chronology and Its Applicability to the Kootenai Region Archaeology

The cultural chronology developed by Roll (1982) for the LAURD project represents an innovation in taxonomic exercise as related to the development of a regional cultural chronology for Northwestern Montana. While Roll borrows some from Northern Plains chronologies, he does not assume that similar cultural manifestations of those chronologies in Kootenai artifact assemblages and subsistence adaptations are the result of direct influences from the plains. Rather, he sees them as in situ developments and as expressions of an adaptation unique to the Kootenai Region.

The Roll-LAURD chronology is applicable to the project area described in this report. Other cultural chronologies have been posed for Northwestern Montana (Choquette and Holstein 1980; Choquette 1984; Thoms 1984). However, Roll's work seems more directly applicable to the project area described herein since the LAURD study area extends to within a mile or so upstream of 24LN1045. Chronologic discussions in this report will therefore focus on the LAURD chronology.

Choquette (in Thoms and Burtchard 1987: 57-120) takes exception to the chronology posed by Roll for the Kootenai River area of Montana and resists adapting that chronology for reasons discussed in the Thoms and Burtchard three volume report. Roll (1982:5.1-5.3) on the other presents a critique of the Choquette (Choquette and Holstine 1980; Choquette 1984) chronology and finds problems with adapting it to the middle reaches of the Kootenai River in Montana. For details on the Choquette and Holstein chronologies, the reader is referred to their reports (Choquette and Holstein 1980; Choquette 1984).

Additional archaeological investigation in the mid to late 1980s focused in the drawdown area of Koocanusa Reservoir behind Libby Dam (Thoms 1984; Thoms and Burtchard 1987). The projectile point classificatory system used in those reports is based primarily on morphology and function and does not draw heavily on extant cultural chronologies even though one author contributed a substantial section on culture histories and chronologies that have been developed for the region [Choquette 1987 in (Thoms and Burtchard 1987)].

As a result of a variety of archaeological investigations in the upper Kootenai River region, the Pass Creek area, the Crows Nest Pass area, the Waterton Park area (all in British Columbia and Alberta, Canada), and the Glacier Park area of Montana, Reeves synthesized the prehistoric, protohistoric, and historic aboriginal cultural history of an area encompassing northwestern Montana (Reeves 2000). In his report Reeves proposes a cultural chronology that is essentially based on a Plains chronology (Reeves 1983; Frison 1978/1991) but with local equivalents or subphases of that Plains chronology. Reeves summarizes important differences between settlement and subsistence patterns of Plains peoples and peoples occupying the mountainous regions of northwest Montana, northern Idaho, southwest Alberta, and southeast British Columbia.

It is beyond the scope of work for this report to comment on the merits or failings of extant cultural chronologies for the Kootenai River area of Montana. Others have done a very exhaustive job of such critiques (Roll 1982:5.1-5.3; Choquette 1987:57-120; Reeves 2000). All researchers recognize the need for a cutural-historical context within which to place archaeological data. Roll's (1982) chronology is used herein because of its specificity for archaeological sites in immediate proximity to the Rainy Creek Site. Whether one agrees or not with Roll's chronology, placing archaeological data within it will allow future researchers the option of revising, amending, removing, or relating Rainy Creek Site data to other classificatory constructs.

(Central to the organizing concepts behind Rolls cultural histories for Northwestern Montana is the subdivision of the region into geographic units with distinct environmental attributes. Roll identified these geographic areas to provide a context for interpreting archeological information gathered during the LAURD project in the Kootenai Canyon.

The LAURD project was carried out during the late 1970's, and involved archeological survey, testing, and data recovery in the area of a proposed reregulating dam downstream from the main Libby Dam in the Kootenai River Valley. The LAURD project area is immediately adjacent to (upstream) the Rainy Creek Site.

As distinguishing attributes, the physical setting and unique configuration of resources in the Kootenai Canyon locality, allowed for definition of a separate geographic division. Archaeological investigations and data recovery within this geographic area provided the opportunity to develop an area chronological framework.

The LAURD project grappled with methodological limitations similar to those present elsewhere in the Kootenai River area. Most of the sites were located on the first and second terraces of the river, virtually the only level, habitable landforms in the canyon. While the density of sites across the terraces was relatively high, the individual sites themselves consisted of little more than clusters of fire-broken rock and bone fragments. Other cultural material was sparse, but included a variety of projectile points.

The general paucity of cultural material together with low variety in artifact classes was not as much an obstacle to interpreting area prehistory as was the nature of the context in which the cultural deposits were found. The natural deposition of sediment during intervals between episodes of human habitation was not sufficient to seal each habitation surface and separate it from the next. Therefore, the archeological deposits were shallow and compressed.

Compressed one atop another, the archeological strata were also exposed to churning and mixing through the action of roots and rodents (bioturbation). Charred roots from natural fires were commonly encountered during excavation. These natural contaminants introduce potential error in radiocarbon dating and interpretations derived from charcoal samples collected in these contexts.

While LAURD archeology presented a less than clear picture of human prehistory, ancillary studies (including area pollen analysis and geoarchaeological analysis of Holocene river terraces) were successful in identifying major environmental and geomorphic events.

The projectile points found at LAURD sites display a limited range of morphological characteristics (outline, hafting style, etc.,), allowing typological grouping. Had these point types been found from site to site, at consistent stratigraphic positions in undisturbed contexts, they might have been singularly useful, as markers for sequential phases of archeological time in the Kootenai Canyon. Additionally if the points had been found in association with charcoal from indisputably cultural contexts, it would have been possible to apply absolute, radiocarbon dates to the phases they represent.

Lacking good stratigraphic control and reliable radiocarbon dates, the projectile point assemblage from LAURD sites could not be used to establish a cultural chronology for the Kootenai Canyon without comparison to other areas. Among projectile points found at the LAURD sites are some with similarities in style to well-dated types found elsewhere in the Plateau and on the Plains.

Roll assumes the LAURD point styles appear relative to each other in a chronological sequence similar to that of their Plains and Plateau analogues. Because neither projectile points nor culturally associated radiocarbon dates predating about 3500 B.C. were recovered during the LAURD project, Roll did not assign a phase to the period pre-dating about 6000 years ago. He does not assume people were not present in the area at that time but without definite archaeological manifestations of earlier age in his project area, defining an earlier phase, similar to that of the Paleoindian or Early Prehistoric Period on the Plains (Frison 1991; Reeves 1983), Bitterroot and Birch Creek in areas of Idaho (Swanson 1972), or Cascade and Windust in Plateau areas (Leonhardy and Rice 1970), would be spurious. By arranging the LAURD points in a sequence similar to that of the Plains, and by referencing that sequence to the limited LAURD radiocarbon data along with the geomorphic and palynological data, Roll came up with a provisional cultural chronology for the Kootenai Canyon area. A brief description of that chronology follows.

Bristow Phase ca. 3500 - 2500 B.C.
Calx Phase ca. 2500 - 1300 B.C.
Kavalla Phase ca. 1000 B.C. - A.D. 200
Stonehill Phase ca. A.D. 200 - 700
Warex Phase ca. A.D. 500 - 1200
Yarnell Phase ca. A.D. 1000 - 1800

The **Bristow Phase** is represented by large, basally-indented projectile points with wide shallow side-notches set low on the blade. These are analogous to Oxbow points found on the Northwest Plains. Archeological deposits from the Bristow phase occur most frequently on the high terraces (2400 -2450 ft. amsl) above Lake Koocanusa, but are also (rarely) found on the river floodplain. Implements associated with the Bristow phase, in addition to the Oxbow-like points, are edge-abraded cobbles.

The **Calx Phase** is characterized by two types of basally-indented points: 1) a lanceolate variety, similar to the NW Plains McKean type, and 2) a basally indented variety, analogous to Duncan and Hanna points. The onset of the Calx Phase corresponds with a climatic shift from warm and dry conditions, to cooler, moister conditions. The earliest widespread archeological deposits in the Kootenai Canyon floodplain are associated with the Calx Phase. It is unclear whether this represents an actual increase in use of the floodplain, or is the result of the abatement of erosion that might have carried away evidence of earlier habitation.

The **Kavalla Phase** is represented by triangular, expanding base, corner-notched points which have their analog on the NW Plains in Pelican Lake points. Side-notched pebbles (possibly net sinkers) are also associated with this phase. During the Kavalla Phase, a pattern of subsistence was apparently established that would be maintained, with minimal alterations, until the introduction of the horse and European trade goods. The close of the Kavalla phase saw the amelioration of cool, moist climatic conditions and the emergence of the modern macro-climate.

The **Stonehill Phase** is identified by points that are triangular, and range from corner-removed to side-notched with wide, shallow notches. These are loosely analogous to NW Plains Besant points. The minor difference between these and points of the Kavalla Phase represents the only observable difference between the two phases. Additional study could show that the Stonehill Phase is a continuation of the Kavalla Phase.

The **Warex Phase** is represented by two point types, both typically thin and delicate, with concave or straight bases and small corner-notches or shallow side-notches placed very low on the blade. Both types are triangular, one having a long outline, the other being nearly equilateral. The latter equates with the NW Plains Avonlea type. These small triangular points are associated with the replacement of the atlatl propelled spear with the bow and arrow. By Warex times, an essentially modern climate and associated erosional/depositional regime along the Kootenai river had been established.

The **Yarnell Phase** is characterized by the small, triangular side-notched point, a form widely distributed around the U.S. beginning about A.D. 800 - 1300, and manifest on the NW Plains in the Old Women's points. This is the final expression of the prehistoric era in the Kootenai region. It may have begun somewhat later and may have been persisted longer than the corresponding period on the NW plains.

According to Roll (1982), the LAURD archaeological record indicates little change in subsistence strategies from the earliest sites in the area (ca. 6000 BP) to protohistoric times. Although there were some changes in climatic patterns and vegetative communities during this period, it appears that medium-size ungulates (deer, wapiti, and sheep) were the focus of subsistence by Kootenai Canyon area peoples throughout prehistory. Deer remains dominate archaeological assemblages from the LAURD project. Exploitation of plants and fish is inferred from artifact assemblages but actual remains of these resources are scant in the archaeological record.

Smith (1984) suggests that by 500 years ago, the Michel Prairie band of Kutenai Indians had already begun to move back and forth across the Continental Divide, presumably to exploit populations of big game (notably bison) present east of the divide. Presently, the archaeological record from the Kootenai River area does not indicate even casual exploitation of bison. Significant populations of resident bison were not likely present prehistorically, in the heavily forested Kootenai Canyon area. Although pre-equine people could certainly have journeyed some distance to avail themselves of the opportunity to hunt bison, it is conceivable that evidence (bison remains) of such journeys would not necessarily make its way back to "home" areas along the Kootenai River.

Protohistory and Ethnographic Background

Protohistory (era before direct white/EuroAmerican contact) of the Rainy Creek area most certainly begins with the Kutenai Indians, or the K'tunaxa (native language spelling) as is now often used. There is some argument as to how long the K'tunaxa have occupied the area of Northwestern Montana. Some believe that the K'tunaxa have resided in the area well back into at least late prehistoric times (Choquotte and Holstine 1980; Choquette 1987). Others suggest they were present by A.D. 1500 (Bryan 1985). While other Native American groups, particularly some of the Salish speaking tribes, are known to have occupied portions of the Kootenai River area, it is the K'tunaxa who were well established in the region by the time of white contact in the late 1700s and early 1800s.

Origins of the K'tunaxa are still being debated by researchers. The K'tunaxa language is considered a language isolate, unrelated to other language families, further complicating determination of origin. Some suggest that the K'tunaxa originally occupied the plains east of the Rocky Mountains but were eventually driven westward by other tribes (Smith 1984; Chamberlain 1893; Hale 1891). Others believe the K'tunaxa have origins west of the Rocky Mountains and that they expanded eastward (Curtis 1911; Ray 1939; Turney-High 1941). There is general agreement that the K'tunaxa exhibited both Columbia Plateau and Plains traits although there is argument as to the dominance of traits from one area or the other (Roll and Smith 1982; Swadish 1949).

According to Reeves and Peacock (1995:23) and others (Turney-High 1941; Schaeffer 1940) the "K'tunaxa consist of two major linguistic and cultural divisions - the Upper K'tunaxa and the Lower K'tunaxa or Lake Indians". The lower division resided along the lower Kootenai River below Kootenai Falls and their subsistence adaptation included a more significant emphasis on fishing and aquatic resources although hunting and gathering was still important (Reeves and Peacock 1995; Roll and Smith 1982; Turney-High 1941; Schaeffer 1940). The upper division occupied the upper stretches of the Kootenai River, the Columbia River headwaters, Columbia Lake regions, and areas of the Rocky Mountains east of the Continental Divide and focused more on big game hunting (Reeves and Peacock 1995; Roll and Smith 1982; Turney-High 1941; Schaeffer 1940).

Citing European trappers like David Thompson and Peter Fidler, Reeves and Peacock state that although K'tunaxa once overwintered on the eastern slopes of the Rocky Mountains only some of the Upper K'tunaxa were continuing seasonal buffalo hunting trips to areas east of the Continental Divide by the close of the 18^{th} century (Reeves and Peacock 1995:23).

The Upper and Lower K'tunaxa were each further divided by a number of politically independent bands (Reeves and Peacock 1995; Schaeffer 1940). According to Schaeffer (1940) the two Upper K'tunaxa bands most proximal to Rainy Creek were the Akiyinik and the Aksuekkinik. The Akiyinik occupied the area around the "Great Bend" of the Kootenai River where it is joined by Fisher River and where the former town of Jennings once stood. The Aksuekkinik resided downstream from the Akiyinik in the area near present day Libby. These two bands are sometimes referred to as the Libby-Jennings band or bands. The mouth of Rainy Creek is situated almost half way between mouth of Fisher River and Libby, and would likely have been within the territory of both bands. The Akiyinik reportedly moved southward to the

Kallispel area before 1850 and the Aksuekkinik moved to the Fort Steele and Windemere areas of British Columbia in the late 1800s (Reeves and Peacock 1995:24).

There was considerable interaction among the bands of the Upper K'tunaxa. Based on oral histories and interviews with the K'tunaxa, Reeves and Peacock (1995:29) state that the Akanahonek or Tobacco Plains band at times journeyed southward in late May to join the Akiyinik for camas gathering in the Pleasant Valley area. Some of the Upper K'tunaxa who did not venture east of the Rockies for summer bison hunting would journey to Bonners Ferry "for duck hunting and to avoid Blackfoot raids" (Reeves and Peacock 1995:29). In summers K'tunaxa "from up and down river" gathered with the Akiyinik, where Libby, Montana now stands, for trading and games. By the mid-1700s relations between the K'tunaxa and Salish groups to the south had improved and eventually the Akiyinik, in particular, begain extending their seasonal rounds into the area east and south of the head of Flathead Lake (Reeves and Peacock 1995:41). After a time the Akiyinik began wintering near Flathead Lake but returned to the Libby and Jennings areas during the summer for the annual K'tunaxa gathering and to hunt (ibid.).

According to oral histories, a primary route for Upper K'tunaxa to reach the Flathead Lake area was along the present route of U.S. Highway 2 from Libby, Montana southward and eastward along Libby Creek to the mouth of Swamp Creek. This trail then passed up Swamp Creek and over a low divide to the upper Fisher River. The trail continued up the Fisher River to Thompson Lakes and McGregor Lake areas before descending along a portion of the Little Bitterroot River valley and finally along Ashley Creek to the Flathead Valley. Alternate trails extended from the Kootenai River up the Fisher River valley to the Horseshoe Lake/Thompson Lake area. This route, sometimes referred to as Kutenai Road, along with the Libby Creek-Swamp Creek route, also provided access to the Pleasant Valley camas collecting area. The Kutenai Road continued down the Thompson River to the Clark Fork Valley (LPS & LWC 1970).

Reeves and Peacock (1995:50) state that K'tunaxa "used both canoes on the Kootenai River & Lakes, Columbia Lakes and headwaters of the Columbia River as well as a trail network which ran along the north-south trending valleys of the Rocky Mountain Trench and Flathead Valley". They go on to indicate that the valley trails intersected with various east-west oriented trails that led across the Rocky Mountains. In addition to the trails that passed along Fisher River and Libby Creek, routes that intersected the Kootenai included the Tobacco River, both southward to the Flathead Valley and eastward into Glacier Park, and the Elk River in British Columbia that was used for passage into the Waterton area (Reeves and Peacock 1995:50-55).

These trail systems are mentioned because they indicate that there was a major trail that passed along the Kootenai River Valley, obviously connecting northerly Upper K'tunaxa bands with bands in the Libby and Jennings areas as well as with Lower K'tunaxa bands. This trail provided access to other east-west trending trails. The trail that developed along the Kootenai River was eventually called the Kootenai Trail and is shown on the north side of the river passing through the mouth of Rainy Creek on an 1899 General Land Office map that was surveyed in 1898 (Bickel 1898/Beattie 1899).

History

The recorded history of the Kootenai Valley begins in 1808 with the journal kept by David Thompson. Seven years earlier, under the auspices of the Hudsons Bay Fur Company, Thompson sent a party of two traders to winter with the Kootenai and initiate trade with them. Although these were probably the first non-native visitors to the area, the traders made no record of their travels.

By the time Thompson himself reached the area, ha had switched loyalties to the Hudson Bay Company's rival, the Northwest Company. In 1807, Thompson established the first Northwest Company fur post at the headwaters of the Columbia near Lake Windemere in British Columbia, naming it "Kootenay House". The following year, Thompson led a small party up the Kootenai Valley, and posted an assistant, Finan McDonald on the north side of the river. There is some question as to the exact location of where McDonald operated this first post that would come to be known as Fort Kootenai. Most researchers assert that the original Fort Kootenai was established near the present site of Libby, Montana (Chance 1981; Spritzer 1979). Citing a 1923 letter from a Jacob A. Meyers of Meyers Falls, Washington written to Mrs. John E. Erickson of Kalispell, Montana, a local history of Libby, Montana (*Nuggets to Timber: Pioneer Days at Libby, Montana*) suggests that the first Fort Kootenai was established at the mouth of Deep Creek four miles below Bonners Ferry, Idaho (LPS & LWC 1970:5). This local history goes on to suggest that the "second" Fort Kootenai was built in the winter of 1808-09, probably at the "Rainy Creek horse range" (LPS & LWC 1970:5) and Chance (1981) and Elliot (1926) also suggest that Fort Kootenai was built on the south side of Rainy Creek. The Libby history volume agrees that Kootenay House was built in 1807 and there is no question that Thompson accompanied Finan McDonald to the Kootenai River the following year. Yet this volume indicates that a second location was established in the Rainy Creek area during the winter of 1808 and 1809. If in fact there were an earlier post established near Bonners Ferry, it must have been very briefly occupied, for weeks or several months at the most. In any case, McDonald set up "Fort Kootenai" and operated trade there for the winter, before returning to the Lake Windemere area Kootenay House in the spring of 1809 (Chance 1981, Spritzer 1979).

Again most sources assert that a second, and more permanent post, also called Fort Kootenai, was established by The Northwest Company in 1811 opposite the confluence of the Kootenai and Fisher Rivers, near the site of Jennings (Chance 1981, Spritzer 1979). The Libby history volume agrees with this location and the dates of construction for a post but suggests that it was built by Joseph Howes and John Parks of the Hudson's Bay Company (LPS & LWC 1970:5). The Libby history suggests that in 1812 The Northwest Company constructed another post at the mouth of Rainy Creek and it operated until 1824 (ibid.). Others (Cox 1831) indicate that the Payette House of the Pacific Fur company was erected at the mouth of Rainy Creek and operated for a year from 1812 to 1813. The Libby history goes on to state that W. Kittson of the Hudson's Bay Company erected a post at the mouth of Rainy Creek in 1829. Since the Hudson's Bay Company absorbed the Northwest Company in 1821 (Chance 1981) the two possible Rainy Creek posts may have been related. The absence of specific cited references for information in the Libby history volume make it difficult to verify the information. Nevertheless, since there are specific names attached to some of the information, it is worth mentioning the statements in this local history document.

There is an interesting connection between the accounts of early posts along the Kootenai mentioned in the Libby history and the citing of letters from Jacob A. Meyers. The Kootenai Times, an early newspaper published in Libby, Montana, began running a series on Kootenai area history in 1914. The first of those articles consisted of a letter from John V. Campbell of Lillooet, British Columbia (Kootenai Times 1914). At the beginning of his published letter Mr. Campbell states that he had already given information on the early history of the area to "Mr. Elliot of Walla Walla and Mr. J.A. Meyers of Meyers Falls". Mr. Meyers apparently had related some of the information provided by Campbell in a 1923 letter to Mrs. John Erickson of Kalispell and that letter was cited by those who put together the history of Libby (*Nuggets to Timber*). Mr. Campbell was a trader for the Hudson's Bay Company who came to the Kootenai country in 1854. At that time, Mr. Campbell was trading in the Tobacco Plains area on both sides of the international border (Canada-USA). He further states that it was not until eleven years later that he visited the country south of the Tobacco Plains. In any event, Mr. Campbell would have been a valuable source of information on the history of trading posts in the Kootenai region.

Mr. Campbell is cited again as a source of Libby area history in a 1953 article in the Western News, a Libby newspaper. That article states that in response to queries by Charles Kessler of Helena in 1918, John Campbell wrote that "The Hudson's Bay post was nearly opposite the Fisher river mouth on the west side of the Kootenay river.....and was built by one Montour and built as the rest were, in a long low log building with a peaked roof of poles covered with cedar bark and earth on top with a fireplace built in one corner" (Western News 1953). The article goes on to quote Campbell as stating, "this house was called by the Indians Ahkie-yie (Ahk-ie-you)" (Western News 1953). There seems to be too many details in this information to disregard. As mentioned above it is often assumed that the Northwest Company built its more permanent Fort Kootenai near the location of where Jennings would develop. The apparent description by Campell of a Hudson's Bay Company post constructed near the same location is interesting. Dates of construction are not mentioned in the Western News article so it is conceivable that reference to the post near Jennings being a Hudson's Bay post may be to the Northwest Company's Fort Kootenai since the Hudson's Bay Company (HBC) acquired the Northwest Company in 1821. However, the name Montour as the builder of the HBC post near Jennings is not a name that appears in association with David Thompson in documents investigated during research for this report.

It would be quite valuable to historic research of western Montana to have the opportunity to inspect the original letters from John V. Campbell to the various correspondents mentioned above (i.e. Jacob A. Meyers, Mr. Elliot, Charles Kessler, Kootenai Times).

Mark White (personal communication 9/2000) reports some documentation for the presence of a short-term trading post at the mouth of Rainy Creek. The nature, duration, and business association of that possible post has not been determined. Unfortunately, the massive disturbance, associated with vermiculite mining and screening, of much of the area around the mouth of Rainy Creek may have destroyed any evidence of early fur trading activity at the locality. Archaeological excavations in 2000 did not yield any artifacts or evidence associated with the fur trade era. The only historic artifacts discovered included a few bottle fragments and a milk glass jar that post-date A.D. 1900. A single blue glass trade bead was also found just above a hearth radiocarbon-dated to about 320±60 years before present and this bead likely associates with a Kutenai/K'tunaxa occupation.

The next several years saw the founding of other posts in the Kootenai Valley by J.J. Astor and the Hudson's Bay Company. By 1846, after the acquisition of the Northwest Company, the Hudson's Bay Company had moved trading operations to the Tobacco Valley north of the Libby and Jennings areas (Chance 1981). By the end of the 1860's, having nearly exhausted the populations of fur-bearing animals, the traders abandoned the Kootenai valley.

Although the fur trade era lasted for fewer than 60 years, it represented, along with contemporaneous missionization, the encroachment of Euroamerican culture that changed forever the character of life for the Kutenai/K'tunaxa. In 1855, the treaty of Hellgate removed some bands of the Kutenai to reservation lands near Flathead Lake. Others were relegated to landless status in British Columbia until the Canadian government established the first reserve in 1888 (White 1992; Roll and Smith 1982).

The final years of the fur trade corresponded with the beginning of commercial mining in the Kutenai region. In the early 1860s, gold miners arrived in the Libby area (White 1992). By the late 1860s, the first of several gold (placer) rushes occurred in the area of Libby Creek. Cycles of mining boom and bust were accompanied by the establishment of various camps and settlements that would have some version of the name Libby (Libbysville, Libby Creek, Old Libby (White 1992).

The 1860s saw the development of steamboat traffic on the Clark Fork River with the need to transport oar from mines in British Columbia to smelters east and west of the Rockies. Although Canadian placers were soon depleted, other rich placers were discovered in the Coeur D'Alene Mountains in the 1880s. Arrival of the Northern Pacific Railroad in the 1880s brought the demise of steamboat traffic (Roll and Smith 1982).

Other Euro-American developments continued in the area. In 1889 the Great Northern Railroad extended through northern Montana. In 1890 construction of a rail line on the south side of the Kootenai River began. This line ran between Kalispell and what would be the location of Jennings (Cheney 1983). Jennings was established along this rail line in 1892 near the confluence of the Fisher and Kootenai Rivers (Roll and Smith 1982). The rail line which ran through the Kootenai valley was eventually extended into Canada to serve the oil fields.

Homesteading began in the area around Libby in the late 1880s and early 1890s. The first post office was established at Libby in 1891 at the site of a rail stop for the new railroad (Cheney 1983). Earliest homesteads in the area were established along valley bottoms (primarily the Kootenai Valley), but in the late 19th and early 20th centuries homesteading began to occur on valley sides (Nelson and Obermayr 1993).

The first sawmills in the area were established in the early 1890s with the demand for railroad ties (White 1992). By the early 1900s larger logging companies began constructing sawmills and began to acquire timber holdings. The initiation of large scale timber operations during this period saw Libby develop as a logging town. Depletion of timber resources on public lands occurred at an alarming rate during this period and concern over this depletion resulted in the creation of Forest Reserves (later to become National Forests). The Kootenai National Forest was established in 1906.

Also around 1906 the railroad became more important in the logging industry and a network of railroad lines and spurs were constructed to increase timber accessibility. By 1920 railroad based logging had peaked and accessible timber was exhausted. From about 1930-1935 truck based logging (with better accessibility to timber) appeared and soon replaced railroad based logging.

During this same period, mining of lead, silver and copper increased in Kootenai area. Most commercial mining in the Kootenai River area had peaked by 1940. However the W.R Grace vermiculite mine, a major Libby area economic factor, operated into the 1980s (Choquette and Holstine 1980).

The construction period for Libby Dam during the late 1960s and early 1970s saw Libby experience a short term boom. The dam was completed by 1975 and filling of the reservoir saw the inundation of numerous farmsteads and the small community of Rexford. The logging industry continues as the mainstay of the Libby area economy.

The mining history of the Rainy Creek area began by at least the late 1890s and early 1900s when isolated copper deposits were discovered (Montana DEQ 2001). An 1897 article that appeared in the Libby Montanian states that copper deposits were first discovered by Bob Rainy in 1887 (Libby Montanian 1897). A later 1906 article in the Western News cites homesteader Ben Thomas who stated that the name Rainy Creek should actually be Rennie Creek, after Bob Rennie whose name was pronounced 'Rainy' but was spelled Rennie (Western News 1906).

The small deposits of copper in the Rainy Creek area failed to attract much attention but during World War I the discovery of vermiculite, near the headwaters of Rainy Creek, by Edward N. Alley would forever change the cultural and natural history of the Rainy Creek and Libby areas. When heated, vermiculite expands to about 15 times its natural size and it quickly found applications in fire-proofing and insulating from heat and cold. Unfortunately, vermiculite deposits in the Rainy Creek area co-occur with tremolite asbestos, a particularly virulent form of asbestos, and a serious threat to human life if inhaled.

Alley began promoting the qualities of vermiculite under the trade name of zonolite and opened a demonstration plant in 1924 and a larger plant in 1926. Mining occurred in the headwaters of Rainy Creek near Vermiculite Mountain. Ore was initially processed and concentrated at the mouth of Rainy Creek and was then shipped to Libby for final processing and distribution. In 1934 Alley sold his interests to two different companies who merged in 1939 to form the Universal Zonolite Insulation Company which changed its name in 1948 to the Zonolite Corporation. In 1963 W.R. Grace and Company acquired Zonolite and further expanded production and development until beginning to close down operations in 1991. The screening plant locality at the mouth of Rainy Creek saw substantial development and improvement during the ownership by W.R. Grace. A new screening tower, large warehouse, underground conveyor tunnels, a conveyor that moved screened vermiculite across the Kootenai River to a rail siding, new buried utility lines including water, gas, electrical, and telephone lines were constructed during this period as were numerous shops, roads, parking areas, and storage pads. After closure of the vermiculite operation in 1991 Grace began some reclamation activities at the Rainy Creek location. During this reclamation period, a rather large area on the south side of Rainy Creek was graded and dozed.

In the 1890s Benjamin (Ben) M. Thomas built a home in the area at the mouth of Rainy Creek. Mr. Thomas was an early resident of Libby who in his younger years was a hardware salesman (LPS & LWC 1970; Brad 1960). He constructed a cabin, a vegetable garden, a fish pond, and planted an orchard with apple, pear, and cherry trees at Rainy Creek (ibid.). His home on Rainy Creek was a stop over and gathering place for local people and travelers. Thomas had the reputation of being a gracious host and he entertained many people at Rainy Creek. An 1899 GLO map that was surveyed in 1898 shows the Thomas cabin on the south side of Rainy Creek in the NE1/4NE1/4SW1/4NE1/4 of Section 32 (Bickel 1898). This location is on property now owned by the Kootenai Development Corporation and the Thomas cabin would have been located to the northeast of the water pump house and embayment. Substantial disturbance has occurred in this area including construction of a jetty, emplacement of a water line, and surface reclamation. No evidence of the Thomas cabin was found in 2000 although the apple trees he planted remained up to asbestos remediation when the trees were all removed. A few bottle fragments and a milk glass jar were found during stripping and removal of asbestos contaminated sediments in a wash that lay between the apple orchard and the former location of the Thomas cabin. These materials appear to date to the period when Thomas lived in the Rainy Creek area.

PREVIOUS ARCHAEOLOGY

by
Stephen A. Aaberg

Previous archaeology specific to the Rainy Creek Site has been limited and was detailed in an earlier section of the report (24LN1045 REVIEW - History of Discovery, Investigative and Evaluative History). The middle reaches of the Kootenai River however have experienced substantial investigation, generally associated with construction of Libby Dam.

During early planning of the dam the Smithsonian Institution carried out investigations in the proposed dam and reservoir areas and identified 26 archaeological sites and tested one of those sites (Shiner 1950). Although a variety of artifacts and features were noted during this investigation, neither sites nor artifacts were placed in any sort of chronological scheme. A few years later investigations were carried out on the Canadian side of the reservoir that would be created by the proposed dam (Borden 1956). Twenty-five archaeological sites were discovered and one was tested. As with the Smithsonian Investigations, various artifacts and features were noted during investigations on the Canadian side, however they also were not placed in chronologic context, except in very general, gross terms.

By 1965, plans for the Libby Dam had taken final shape and the National Park Service contracted with the University of Montana (UM) to carry out investigations of the proposed dam and reservoir areas. During two seasons of fieldwork by the UM, 28 archaeological sites were recorded, 12 of which were tested (Taylor 1973). The UM attempted to relocate the sites recorded by Shiner (1950) but could only find two of those sites. During this period, as part of a proposed road and bridge construction project, the UM also carried out salvage testing of 24LN10 at the mouth of the Fisher River (Taylor 1968). In 1969 the UM also undertook a brief survey of the proposed Libby reregulating dam and pool and recorded two new archaeological sites and relocated one of the previously recorded Smithsonian sites (Taylor 1969).

Although a number of sites were recorded and tested during the various UM projects, radiocarbon dates were not obtained. Included in various artifacts noted and collected were projectile points that Taylor attempted to classify into chronological scheme (Taylor 1968, 1969, 1973). Points attributed to the Middle Prehistoric (after Frison 1978/1991; Reeves 1983), including a purported Oxbow specimen, were found during these UM projects but conclusive evidence suggesting occupation of the area earlier than the middle Middle Prehistoric Period were lacking. Among the artifacts noted by the UM were numerous small, side-notched arrow points and pestles, both of which were attributed to Kutenai/K'tunaxa occupations (Taylor 1973:118-120).

Archaeological investigation along the Kootenai River in Canada, within the northern portion of the reservoir that would be created by Libby Dam, was renewed in 1971 and continued through the mid-1970s (Choquette 1974, 1973, 1971a, 1971b). These investigations included survey, testing, and excavation and a variety of tools and faunal remains were recovered and various features were noted. A few areas of the Libby reservoir area on the U.S. side were inspected during the Canadian projects but these investigations were essentially at the reconnaissance level.

As mentioned earlier in this report, in 1975 US ACE-SD archaeologist David Munsell surveyed a stretch of the Kootenai River below Libby Dam within a reach that would be affected by a proposed reregulating dam. Munsell recorded a number of cultural properties at that time including the Rainy Creek Site (24LN1045). In 1976, well after completion of Libby Dam and filling of the reservoir behind it (Lake Koocanusa), Montana State University (MSU) undertook a survey of a statistically justified sample of the pool area (Jermann and Aaberg 1976). This survey yielded 34 new archaeological sites and a number of isolated artifact occurrences and led to a prediction that about 400 sites could likely be present in the U.S. portion of the Lake Koocanusa pool and shoreline area. In addition to documenting sites within the pool area, the 1976 MSU survey also noted a variety Middle Prehistoric Period to Late Prehistoric Period (after Frison 1978/1991; Reeves 1983) projectile points from the sites.

Because of proposed construction of recreation and access sites on the shores of lake Koocanusa, additional archaeological survey was carried out by MSU in 1979 (Roll and Bailey 1979). Four new archaeological sites were located during this project and a variety of stone artifacts were noted. A number of projectile points were noted during this survey.

Test excavations were carried out at the Fisher River Site (24LN10) in July of 1976 as part of a State Highway 37 reconstruction project (Roll 1979). Lithic artifacts, including late Middle Prehistoric Period and Late Prehistoric projectile points, were recovered during this project. Faunal remains, dominated by deer, were also noted, as were copious quantities of heat-altered or fire-cracked rock.

The University of Idaho (UI) began archaeological investigations of the proposed Libby reregulating dam and pool area in 1977 and investigations continued through 1978. During these investigations all previously recorded sites were investigated and 24 new archaeological sites were recorded (Choquette and Rice 1978. By the end of 1978, a total of 64 cultural properties had been recorded along the Kootenai River from Libby Dam downstream to just below Rainy Creek. According to Choquette (1987) four prehistoric sites had been excavated and 36 sites had been formally tested by the University of Idaho during 1978 and 1979.

Montana State University (MSU) continued evaluation and mitigation of prehistoric sites in the Libby reregulating dam and pool area in 1979 (Roll and Smith 1982; Roll 1982). The MSU project saw major archaeological excavations at five sites and evaluative testing was carried out at two additional sites.

Sites most proximal to 24LN1045 that received some form of subsurface evaluation included a cluster of sites at the location of the proposed reregulating dam about 1.6 miles upstream from Rainy Creek. The mitigated/excavated site most proximal to Rainy Creek was a site near the haul road for the reregulating dam project, about three miles upstream.

The UI and MSU projects were intensive and included a variety of technical ancillary studies including geoarchaeological analysis. A number of radiocarbon dates were obtained from varying contexts on these projects and artifact recovery included chipped stone tools, ground stone tools, bone, heat-altered rock, and some historic materials. The UI and MSU work, along with data from previous investigations in the area, led to development of two provisional cultural chronologies for the Kootenai River region (Roll 1982; Choquette and Holstine 1980).

Proposed upgrade of a Bonneville Power Administration (BPA) electrical transmission line that would run from Libby Dam, along the north side of the Kootenai River before swinging southward to Albeni Falls Dam, Idaho resulted in compilation of a regional cultural resource overview of the Kootenai area (Choquette and Holstine 1980). It was in this overview that the first detailed culture history of the region was proposed. The proposed culture history was based on an integration of data from numerous projects in the Kootenai region, from both the American side (including the aforementioned UI work) of the border and the Canadian side (ibid.).

As BPA's plans for constructing the new Libby Dam to Idaho transmission line progressed, archaeological survey of the entire right-of-way was completed by 1983 (Choquette et. al. 1984). During this project, 29 sites were recorded, all within the Kootenai River drainage, and with the exception of one site, all downstream from Libby. Eighteen of the sites received some degree of subsurface testing. A variety of artifactual materials was recovered and occupations ranging from older than 7000 years up to late prehistoric times were documented. These investigations led to refinement of the earlier posed Choquette and Holstine (1980) regional cultural chronology (Choquette 1984).

Investigations in the Lake Koocanusa pool area were renewed in 1981 when the Seattle District of the ACE contracted with the Center for Northwest Anthropology-Washington State

University (CNA-WSU) to carry out additional survey and excavation in the pool drawdown area (Thoms 1984). This project, carried out between 1981 and 1984, investigated previously recorded sites and identified a number of previously unrecorded sites. A total of 222 prehistoric sites and 27 historic sites were found to occur in the project area and 57 of them received some degree of subsurface testing. Diverse artifact assemblages were noted at many of the sites and included a variety of projectile points. A model for human land use systems of the region was first posed as a result of work carried out in 1981 and 1982 (Thoms 1984). Additional work was proposed in the pool drawdown area and focused on excavations at one site and refinement of the earlier posed human land use model (Thoms and Burtchard 1987).

Excavations at a prehistoric site just below Libby Dam were carried out by Cascadia Archaeology in 2000 at about the time investigations at the Rainy Creek Site were undertaken (Rebecca Timmons, personal communication 8/2000). The report on this ACE-sponsored project was in preparation at the time of completion of the Rainy Creek report.

FIELD METHODOLOGY

by
Stephen A. Aaberg

Developing an approach to data recovery through archaeological fieldwork and excavations at 24LN1045 proved to be a daunting task because of the fact that the site lay entirely within an area that had been contaminated with tremolite asbestos. Even before fieldwork began in 2000, the site had been cordoned off and lay within an EPA containment area. The EPA, through its contractors, had already determined that asbestos contaminated soils ranging in depth from surficial to over 10' deep occurred variably over the entire site. Medical investigations of the human population of the Libby area had already indicated an inordinately high rate of asbestos-related disease. Some medical opinions suggested that even short term exposure (through inhalation) without personal protective equipment could lead to serious respiratory disease.

At the onset of archaeological investigation of 24LN1045, even during the phase of site investigative history review and a review of the Section 106 process, the EPA through its contractors provided ACRCS with a report detailing the circumstances of the emergency response project at the old W.R. Grace screening plant locality. In that documentation, all medical and safety requirements were discussed in detail. ACRCS was required to put all archaeological field personnel who would be working on the site, within the containment area, through Hazardous Waste Operations Emergency Response (HAZWOPER) training. All such personnel would also be required to wear personal protective equipment including tyvex suits, steel-toed boots, hard hat, rubber gloves, and a full face respirator. A crew of six archaeologists, including the project geoarchaeologist, went through HAZWOPER training in Libby, Montana the week preceding the beginning of fieldwork.

Prior to HAZWOPER training and the beginning of fieldwork, ACRCS was contracted by CDM to provide a history of site investigations and to provide a written review of state and federal cultural resource laws and statutes applicable to the Libby Asbestos Project (Aaberg 2000). ACRCS was also contracted to develop a data and significant information recovery plan.

An initial data recovery plan was submitted before completion of the final review report cited above. The first data recovery plan called for excavation of 24 to 48 square meters of site area that would be carried out by a crew of 14 people during 10 to 20 days of fieldwork. The EPA and its contractors determined that the complexities of safety requirements and the size of decontamination facilities at the old screening plant precluded a project of that size. Ultimately a hand-excavated sample of nine square meters, augmented by 10 backhoe trenches was accepted by the EPA. Archaeological crew size was reduced to six people since the decontamination facility at Rainy Creek was already running at capacity with an asbestos remediation field crew, safety crew, and engineering crew of over 20 people. The archaeological field crew spent 21 days on site during the data recovery project.

What is normally taken for granted during archaeological field projects was an extreme challenge during excavations at 24LN1045. Equipment normally used during archaeological investigations could not always be used during mitigation at Rainy Creek. Any equipment taken into the containment area had to go through decontamination, which was mainly washing with pressurized water and vacuuming. Any equipment with many nooks and crannies, such as cameras and transits, simply could not be taken into the site area. Disposal underwater cameras were used instead of the usual SLRs or digital cameras. Therefore, camera angles and views were limited. The full face forced air respirators, which included a forehead to chin Plexiglas visor and respirator made it extremely difficult to focus cameras with any precision (Figure 36). To compensate for this numerous photographs of the same view were often taken. CDM assisted with some instrument mapping through use of a total station laser system, which could be used outside the containment area to obtain shots within the containment area. All excavation units and backhoe trench locations were surveyed and tied to an existing detailed contour map of the entire project area. Because of the problems associated with instrument surveying within the containment area, elevational control was maintained through use of line levels. Attempts were made to shoot in at least one corner of each excavation unit with an instrument.

All forms and records maintained during the excavations had to be vacuumed at the end of the field project. Level forms, excavation unit forms, feature forms, stratigraphic forms and profiles were all maintained during the project. Excavation units and geoarchaeological backhoe trenches were profiled.

Because of safety requirements, all sediments removed during excavation had to be water-screened to reduce the possibility of introducing asbestos fibers into the air (Figure 37). All sediments in excavation and screening areas had to be kept wet for dust control. Water screening was accomplished using high pressure hoses and water trucks or high pressure pumps with intake hoses placed in Rainy Creek or the Kootenai River. All sediments removed during excavation were water-screened through 1/8" mesh hardware cloth. Excavation was accomplished through use of trowels and shovels and excavation was generally carried out in 10cm levels. Whenever possible features and artifactual materials were exposed in place and

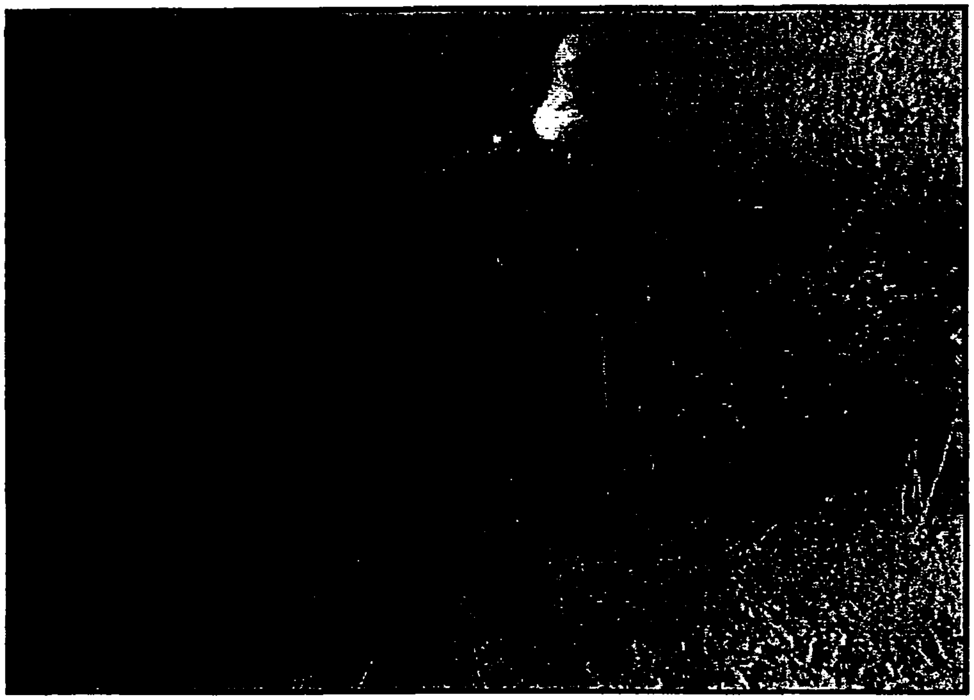


Figure 36: 24LN1045, ecavation in XU: N-2, looking southwest.

Figure 37: 24LN1045, water screening in north portion of site, looking northwest.

excavation units and attempts were made to locate excavation units in undisturbed sediments. One existing backhoe trench (North Trench) originally excavated during asbestos remediation was used to facilitate geoarchaeological analysis on the north side of Rainy Creek (Figure 4) and nine new trenches were placed on the south side (Figure 5). Eight of the backhoe trenches (North Trench, Trenches 3-5, Trenches KDC-1 through KDC-3) were excavated into the alluvial fan. Two trenches (Trenches 1-2) were excavated into the Kootenai River overbank terrace on the south side of Rainy Creek just to the south of the mouth of the creek. The trenches ranged in length from 7 meters to 48 meters. With the exception of the North Trench, backhoe trenches were excavated to between 2 and 3 meters below surface.

Backhoe trenches and excavation units were photographed and stratigraphic profiles were made for all trenches and units. Sediment samples were collected from the backhoe trenches and constant volume samples were collected from each level in each excavation unit. It was hoped that various ancillary technical studies could be undertaken on the constant volume samples (CVS) but because of budget cuts and the complexities of processing potential asbestos-contaminated sediment, the CVS sediments were not analyzed. However, they were retained for possible future analysis.

Total area sampled by hand excavation amounted to nine square meters and volume of sediment removed from those units was 8.7 cubic meters. Backhoe trenches sampled about 545 square meters of the site surface.

STRATIGRAPHY AND CHRONOLOGY

by
Stephen A. Aaberg, William P. Eckerle, Rebecca Hanna and Sasha Taddie

Stratigraphy and Geoarchaeological Relationships

The primary occupied portion of 24LN1045 occurs on the alluvial fan. As mentioned earlier in this report the fan likely began building soon after deglaciation in the latest Pleistocene or earliest Holocene. Fan-building continued through the Holocene and continues into the present. One, and probably another, Kootenai River overbank terraces (T1 and T2) are present within the site boundaries. Both these landforms began building much more recently than did the alluvial fan. The T1 terrace appears to be depositional rather than erosional at 24LN1045. The best defined portion of the T1 landform occurs just upstream from the mouth of Rainy Creek. It had been so disturbed by vermiculite screening activities that the decision was made not to place excavation units on it although two backhoe trenches were excavated into it. Excavation unit S-5 was placed on in undisturbed remnant of T1 upstream from the larger remnant just described. The T2 landform is poorly defined in the site area and appears to have been eroded and planed by the river and is mostly covered by fan deposits.

T1 Terrace

A radiocarbon date of 320±60 BP (conventional radiocarbon age: Beta 154450) was obtained from an intact cultural feature (Feature 1-S-5)(Figurs 38 and 39) exposed in Level 3 of unit S-5. The radiocarbon sample was collected from feature fill that lay an average of 17 to

19cm below surface (27-29cm below datum) although a small pocket of feature fill extended to 24cm below surface (34cm below datum). Although it is likely that cultural deposits in this unit are intact and undisturbed, occupations appear to have been so regular that separation of occupations by sterile sediments was not discernible in profile. Relatively dense quantities of heat-altered rock, bone fragments, and lithic detritus (less dense) were recovered from levels above and below the feature. Cultural materials were found in all but the final level (Level 10) although occupational artifacts thinned below Level 6.

Large rounded boulders occupied the lower half of unit S-5 (Figures 34 and 35) and coarse sand, small gravels and cobbles were found in Level 10 suggesting that initial phase overbank and channel marginal deposits had been encountered. Cochran and Leonhardy (1982) and Roll and Smith (1982) indicate that the T1 terrace was sometimes cut into existing, older sediments. The large boulders encountered in unit S-5 and the presence of numerous large, unsorted boulders and cobbles off the west edge of T1 adjacent to the unit tend to suggest that the Kootenai River cut into and eroded alluvial fan deposits that included some large boulders. T1 was then constructed over the planed and eroded fan toe.

Assuming that overbank deposition was more accelerated during the initial phases of terrace building, when the terrace surface was closer to river level, it is probable that sediments in this overbank landform are not over 1500 years old. In fact, it is possible that this terrace is even younger. Roll and Smith (1982:4.7) in discussing stratigraphy of site 24LN528 suggest Late Holocene alluvium was "cut into the Qal sediments beginning at sometime before 1,000 BP. Data from Rainy Creek tends to support their observation although it seems likely that this process did not occur much before 1,000 BP.

Approximately 20cm of sediment has been deposited over the last 300 years which breaks down to an average annual rate of deposition of about 0.7 cm for the uppermost sediments when flood episodes were likely less regular than during formation of basal sediments (this assumes that river planation has not removed substantial amounts of sediment). Two A-horizons (A1 and A2: Figures 34 and 35) were identified in the upper half of unit S-5. Obviously there were some periods of depositional stability (lower frequency of major flood episodes) during the later phases of terrace building since these A-horizons would require enough time for organic material to build. A horizons were not identified in the lower portion of the unit suggesting flood episodes were more frequent, interrupting the formation of vegetation-derived, organic-rich soils.

It is not unreasonable to assume that major occupations of the overbank T1 terrace, as represented in data recovered from unit S-5, occurred within the past 600 years. Artifactual materials, believed to be essentially intact, occur within and between A- series horizons, suggesting that occupation was regular even during times of increased river flooding. Unfortunately, the number of occupations was not discernible during 2000 excavation. The only time diagnostic artifact recovered from this unit was a glass trade bead, indicating that occupations from late prehistoric times continued through protohistoric and historic times in this portion of the site.

Alluvial Fan

Three radiocarbon dates obtained from one cultural feature and two organically enriched soil horizons tend to indicate that deposition on much of the fan occurred at a much slower rate than did deposition on overbank terraces. Obviously, when considering the dynamics of fan building there may have been instances where localized alluvial pulses in some areas of the fan resulted in substantial single event depositional episodes. The alluvial fan encompassing most of 24LN1045 was not constructed entirely by materials contributed by Rainy Creek. Southern portions of the site, south of Rainy Creek, obviously include slope wash from adjacent mountain slopes. A short, steep-walled, unnamed drainage just south of Rainy Creek also contributed substantial fan deposits to southern portions of the site.

Even considering these variables, it appears that, as a rule, fan building following deposition of Mazama ash, was relatively slow. Ash was identified in two backhoe trenches, one on the north side of Rainy Creek (North Trench) (Figures 11 and 12) and one on the south side of Rainy Creek (Trench 4) (Figure 30). In the North Trench, Stratum III contained redeposited or reworked ash between 122 and 142 cm below surface. In Trench 4 Stratum III with the ash, was found between 113 and 118cm below surface. Averaging out rates of deposition based on a ca. 6500 year old date for Mazama ash, fan building proceeded at about 0.02 cm/year.

A cultural feature, with bone and charcoal, was exposed in the north wall of Trench 3 (south side Rainy Creek) (Figures 13, 14, 15, 38, and 39). The top of the feature was at about 39cm below surface and the bottom was at about 50cm below surface. A radiocarbon sample of charcoal enriched sediment from the feature was submitted for dating. A conventional radiocarbon age of 1810±50 BP (Beta 154451) was returned from the sample. This date also supports an average annual rate of deposition of about 0.02cm per year as is also indicated by the depth of burial of Mazama ash as discussed above.

A radiometric date of 3,720±50 BP (Beta 154452: Conventional radiocarbon age) was obtained from a sediment sample collected from a Ab2 horizon identified in Trench KDC-1 at 124-150cm below surface (Figure 16). Mazama ash was not identified in this trench. This trench, located near the present toe of the alluvial fan demonstrates the irregularities and vagaries in fan building processes. While rate of annual deposition as indicated by the radiocarbon date is relatively slow (0.04cm per year), that rate is still twice the rate as is indicated in Trench 3 and the North Trench.

The dated Ab2 horizon in Trench KDC-1 is culture-bearing as is younger horizon Ab1. Unfortunately, cultural materials were only observed during profiling of this trench and nearby excavation unit S-5 was placed on a different landform where the same horizon sequence was not apparent. Interestingly, horizons Ab1 and Ab2 are separated by over 50cm in the eastern half of the trench but merge in the western portion of the trench. This merger indicates that deposition on the fan toe was slower and the occupation/land surface of the fan toe was more stable. It also indicates that stratigraphic separation of cultural occupations is quite variable over the fan surface. It is likely that discrete occupations would be difficult to discern in areas such as the west end of Trench KDC-1. Yet, just several meters east, occupations within Ab1 and Ab2 would be well separated.

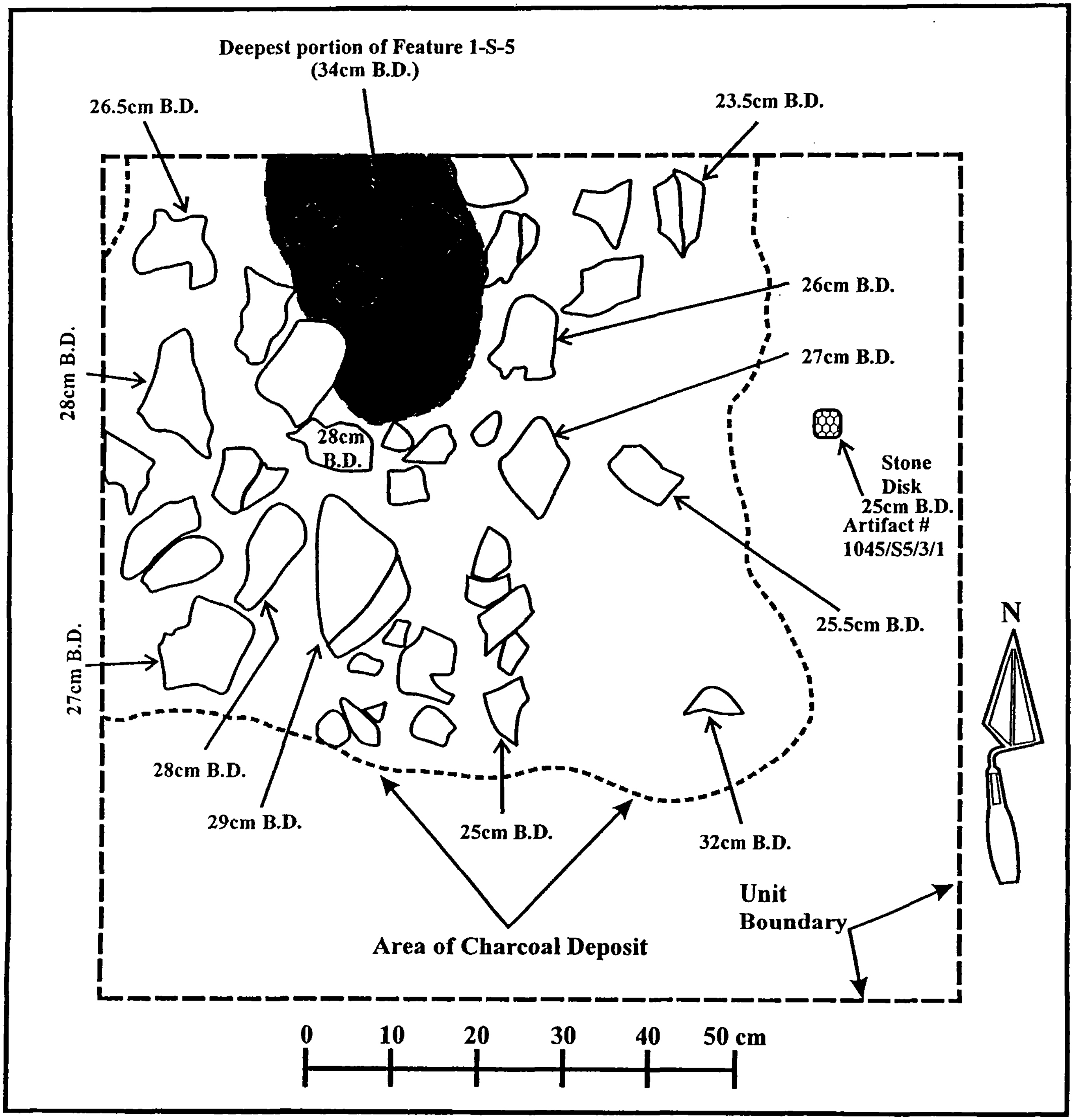


Figure 38: Detailed map of stones in Feature #1 in XU: S-5.

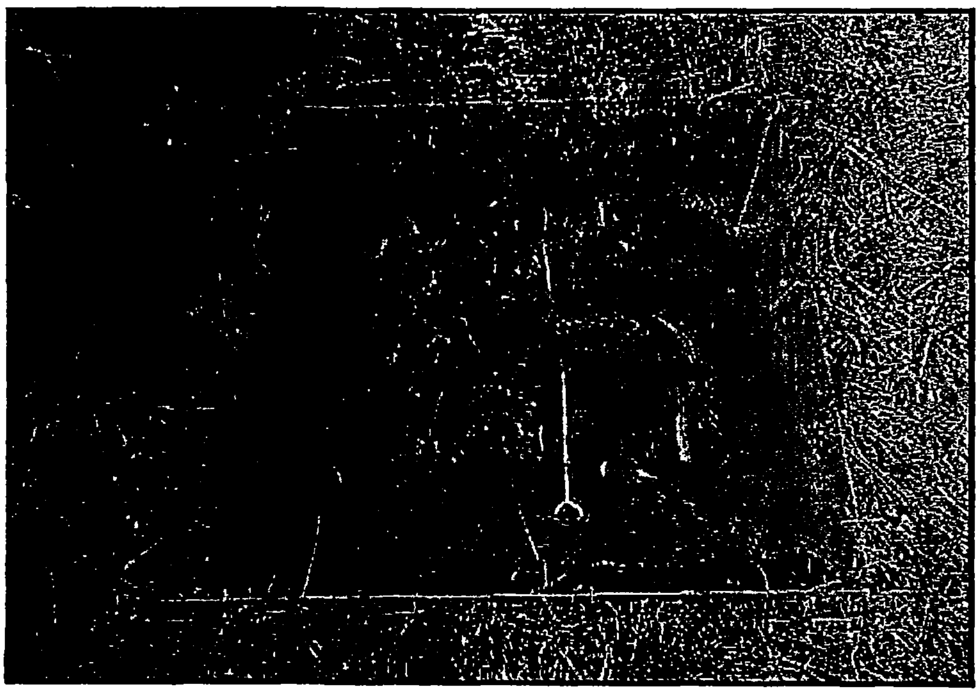


Figure 39: 24LN1045, XU: S-5, Feature #1 fully exposed, looking north.

The third radiocarbon date from fan deposits was obtained from a culture-bearing horizon (Ab or Awb) in Trench KDC-2 (Figures 17 and 18). A sediment sample collected from this horizon returned a date of 2860±60 BP (Beta 154453: Conventional radiocarbon age). This horizon lay from 118 to 121cm below surface, again demonstrating the variability of fan building. An annual rate of deposition of about 0.04cm seems slow but is still more accelerated than in other areas of the fan.

With data recovered during the 2000 field season it is apparent that the best possibility for identifying stratified intact cultural deposits that can be segregated by occupation, occurs on the T1 terrace. Earlier in this report, it was suggested that there is a high probability that cultural deposits within the alluvial fan have been disturbed by fan-building processes. That is not to say that intact cultural deposits are not present within the fan as is indicated by exposure of an intact cultural feature in the north wall of Trench 3. There is also great difficulty in intra-site soil horizon correlations on such a large site, the majority of which occurs in fan deposits. This is demonstrated by the presence of Ab1 and Ab2 horizons that are well separated on one end of backhoe Trench KDC-1 and merged on the other end. However, analysis of radiocarbon dates obtained from fan deposits also indicate that gross stratigraphy is likely retained in portions of the site within the alluvial fan even if individual occupational events may not retain integrity. This is demonstrated by dating of a culture-bearing soil horizon in backhoe Trench KDC-2.

Cultural Stratigraphy and Cultural Affiliations

T1 Terrace

A single 1m x 1m excavation unit (S-5) was the only hand excavation carried out on the T1 landform. The only culturally diagnostic artifact recovered from the unit was a blue glass trade bead found in the first 10cm below surface. An intact cultural feature formed of heat-altered rock and including a very slight excavated basin with charcoal and oxidation was exposed between 15 and 25cm below surface (Figures 38 and 39) and it yielded a conventional radiocarbon age of 320±60 BP (2 Sigma Calibration: A.D. 1440 to 1670).

There is little question that occupations represented by cultural materials in the upper levels of unit S-5 are associated with the Kutenai/K'tunaxa. Many researchers place the K'tunaxa in the Kootenai River area by A.D. 1500 (Smith 1984; Bryan 1985) while others suggest they were present even earlier (Reeves 2000; Choquette 1987, 1984; Choquette and Holstine 1980). In fact, Choquette (1987) suggests that two particular bands of K'tunaxa are associated with occupation of the Middle Kootenai River area. He describes the Akiyinek (sp.) complex (named for a particular band of K'tunaxa) as dating to between 1,000 and 500 years ago (Choquette 1987:101). He suggests that, among other things, this complex is "characterized archaeologically by abundant red and golden dendritic chert" (Choquette 1987:101). Choquette goes on to suggest that the Akahonek complex (also K'tunaxa associated) appears about 1,400 years ago, was for a time contemporaneous with Akiyinek, and persists until historic times (ibid.). He indicates that Top-of-the-World (TOW) chert dominates Akahonek assemblages. Reeves (2000) also suggests that dominance of TOW chert is characteristic of what he describes as the Tobacco Plains Phase which ranges from about 800 radiocarbon years before present to about 200 years before present. In unit S-5 TOW chert dominates the upper levels and begins to diminish in lower levels where argillite becomes more common. The debitage record from unit

S-5, together with the ca. 320 year old radiocarbon date and the recovery of a glass trade bead tend to support the suggestions by Reeves and Choquette that use of TOW chert increased through time and dominance of TOW chert in assemblages may be diagnostic of K'tunaxa occupations.

It is likely that occupations represented by material culture in the first 30 to 50cm below surface on the T1 terrace at the Rainy Creek Site are associated with the Kutenai/K'tunaxa. Lower levels may also be associated with K'tunaxa occupations but in the absence of radiocarbon dates and/or time diagnostic artifacts (beyond lithic debitage) from lower levels, a strong argument cannot be made herein for those associations on the T1 terrace.

Alluvial Fan

Earlier in this report, it was suggested that cultural occupations within the alluvial fan likely had experienced disturbance from fan-building processes. It is also apparent that intact features can occasionally be found within the fan as is demonstrated by discovery of a cultural feature in the north wall of backhoe Trench 1.

It is also apparent that gross stratigraphy has been retained in portions of the alluvial fan. Two deeply buried, culture-bearing soil horizons were discovered in backhoe trenches KDC-1 and KDC-2 (Figures 16, 17 and 18). Unfortunately, these horizons were not found to be culture-bearing until the final 3 days of fieldwork and they were not formally sampled through hand excavation. Four gallon bulk soil samples were collected from both horizons for radiometric dating. The samples were sorted and screened before being submitted for radiocarbon dating. Although several flakes were noted in the Ab/Awb horizon during profiling of KDC-2, cultural materials of any sort were not found in the bulk soil samples collected from the horizon. The bulk soil sample from the Ab2 horizon in KDC-1 was collected from the eastern portion of the trench where the Ab1 and Ab2 horizons were well separated. Screening of the bulk soil sample yielded 8 pieces of heat-altered rock, 7 pieces of tiny, unidentifiable bone fragments (6 unburned and 1 calcined), and three thinning flakes (1 basalt, 1 grey chert, and 1 argillite).

Because of the complexities of alluvial fan stratigraphy and fan-building processes, correlations between the two trenches could not be determined. It is obvious that in portions of the alluvial fan these more deeply buried, culture-bearing horizons are well separated from cultural occupations that are present within the first 50cm below surface. These deep horizons likely retain good stratigraphic integrity but it could not be determined how many cultural occupations occur within them and culturally diagnostic artifacts were not found in the very small examined bulk soil samples.

If the bulk soil radiocarbon dates are accepted as reliable indications of age for cultural deposits contained in the two culture-bearing soil horizons in trenches KDC-1 and KDC-2 then cultural occupations in both would associate with Choquette and Holstine's (1980) Inissimi Complex with a temporal range of 3000-50 B.C. Using Roll's (1982) culture history, the ca. 3720 BP occupations in trench KDC-1 would associate with his Calx Phase (2500-1300 B.C.) and the ca. 2860 BP occupations in trench KDC-2 would associate with the more recent end of the Calx Phase or the earlier end of the Kavalla Phase (1000 B.C. - A.D. 200). Reeves (2000) would place the ca. 3720 BP occupation(s) in the McKean Phase or in the local equivalent in

Glacier Park region, the Many Glacier Subphase (ca. 4500-3500 radiocarbon years ago). The ca. 2860 BP occupation(s) in trench KDC-2 would fall within the range of Reeves' Glacier Park region Blue Slate Canyon Subphase (ca. 3500 - 1600 radiocarbon years ago), the local equivalent of the Plains area Pelican Lake Phase.

If it is accepted that gross stratigraphy is retained over much of the alluvial fan, then all occupations sampled through hand excavated units would post-date ca. 2860 BP. The dated horizon that yielded that date lay 118 to 121cm below surface in trench KDC-2. The dated horizon (ca. 3720 BP) in trench KDC-1 lay 124 - 150cm below surface. As described earlier, an intact cultural feature exposed in the north wall of backhoe Trench 3 yielded a radiocarbon date of ca. 1810 BP and the feature lay between 39 and 50cm below surface (Figure 14).

The zone that yielded the most cultural material in all units placed on the alluvial fan lay from surface to about 40cm below surface. Cultural materials were found throughout this zone and during hand excavation stratigraphic separation of occupations within this zone could not be discerned. This dense, culture-bearing zone encompassed all of Stratum IVc and often extended into Stratum IVb. Horizons identified in Trench 3 within Stratum IVc are A (0-7cm BS), AB (7-20cm BS), and Bw (20-70cm BS). These horizons were continual in the profile exposed in 48-meter-long Trench 3 (Figures 13, 14 and 15). A continuous Ck horizon (70-90cm) was identified in Stratum IVb of Trench 3 except in the west end of the trench where it occurred in Stratum IVa.

Hand excavations suggest that intense occupations of the Rainy Creek alluvial fan, as represented by dense material culture remains in the first 40cm below surface, likely began about 2000 years ago, toward the end of Roll's Kavalla Phase, Reeves' Pelican Lake Phase/Blue Slate Canyon Subphase, or Choquette and Holstine's Inissimi Complex. Post 2000 BP occupations heightened through Roll's Stonehill, Warex, and Yarnell Phases (Reeves' Crandell Mountain Subphase/Besant Phase, Tobacco Plains Phase/Old Women's Phase; Choquette and Holstine's Inissimi Complex, Transitional II period, Akiyinek Complex, Akahonek Complex) and into protohistoric and historic times. Occupation of the alluvial fan began much earlier (by at least ca. 3720 BP) as is indicated by two culture-bearing horizons that lay over one meter below surface. The nature of these earlier occupations cannot presently be characterized since they were not adequately sampled through excavation. The presence of these two more deeply buried horizons suggests that even more deeply occurring, culture-bearing horizons or strata, could be present within the alluvial fan.

Radiocarbon Dates

As described above, four radiocarbon samples were collected from site deposits during the 2000 field season (Table 1). Two of the samples were collected from cultural features and two were collected from organic, culture-bearing strata. Three of the samples were collected from localities within the alluvial fan and one was collected from the T1 terrace. All four samples underwent bulk low carbon analysis on submitted sediment using standard radiometric procedures. Acid wash pretreatment was used on the four organic sediment samples.

Table 1: **Summary of radiocarbon dates and data from 24LN1045.**

Provenance	Area	Sample Type	Dating Technique	Lab Number	Conventional C14 Age	Calibrated Results: (2sigma, 95% probability)
Unit S-5 (F-1)	T1	Low carbon sediment; hearth contents	Standard radiometric	Beta-154450	320±60 BP	A.D. 1440-1670 (510 - 280 BP)
Trench 3 (F-1)	Fan	Low carbon sediment; hearth contents	Standard radiometric	Beta-154451	1810±50 BP	A.D. 85-350 (1865 - 1600 BP)
Trench KDC-2 (culture-bearing paleosol)	Fan	Low carbon sediment	Standard radiometric	Beta-154453	2860±60 BP	1210-880 B.C. (3160 - 2840 BP)
Trench KDC-1 (culture-bearing paleosol)	Fan	Low carbon sediment	Standard radiometric	Beta-154452	3720±50 BP	2280-1965 B.C. (4230-3915 BP)

Sample 24LN1045-S5-F1 (Beta 154450) consisted of the entire contents of Feature 1 found from 17 to 24cm below surface in unit S-5 on the T1 terrace (Figures38 and 39). Heat-altered rocks were found at the top of this feature and were underlain by a slight basin filled with organic sediment and degraded pieces of charcoal. Slight oxidation was evident at the base of the basin. Weight of the hearth fill amounted to 5.6kg and the entire collected sample was submitted for dating. This sample returned a measured/conventional radiocarbon age of 320±60 BP with a two sigma calibration of A.D. 1440 to 1670 (510 to 280 BP).

Sample 24LN1045-TR3-F1 (Beta 154451) consisted of the entire contents of Feature 1 found from 39 to 50cm below surface in the north wall of backhoe Trench 3 on the alluvial fan toe (Figure 14). Heat-altered rocks were found near the top of the feature and were underlain by a slight basin infilled with organic sediment and degraded charcoal. Slight oxidation was noted at the base of the basin. Weight of the feature fill amounted to 2.4kg and the entire collected sample was submitted for dating. This sample returned a measured/conventional radiocarbon age of 1810±50 BP with a two sigma calibration of A.D. 85 to 350 (1865 to 1600 BP).

Sample 24LN1045-KDC-2 (Beta 154453) was collected from an organically rich, culture-bearing paleosol that was identified from 118 to 121cm below surface in backhoe Trench KDC-2 near the center of the alluvial fan (Figures 17 and 18). Several cultural flakes were noted in this paleosol during trench profiling but screening of the sample submitted for dating did not yield cultural materials of any sort. Weight of the collected sample amounted to 8.9kg and the entire sample was submitted for dating. This sample returned a measured/conventional radiocarbon age of 2860±60 BP with a two sigma calibration of 1210 to 880 B.C. (3160 to 2840 BP).

Sample 24LN1045-KDC-1 (Beta 154452) was collected from an organically rich, culture-bearing paleosol that was identified from 124 to 150cm below surface in backhoe Trench KDC-1 near the toe of the alluvial fan (Figure 16). Butchered bone, heat-altered rock, and lithic detritus were observed in this paleosol and were also found in the collected sample. Weight of the sample submitted for radiocarbon dating was 7.5kg. This sample returned a measured/conventional radiocarbon age of 3720±50 BP with a two sigma calibration of 2280 to 1965 B.C. (4230 to 3915 BP).

Typological Crossdating

The sample size of projectile points recovered during hand excavation at 24LN1045 is small making intra-site statistical analysis of form a spurious exercise. The LAURD project carried out by MSU (Roll and Smith 1982; Roll 1982) resulted in recovery of a relatively large sample of projectile points from sites excavated along the Kootenai River in proximity to Rainy Creek. Area projectile points were also discussed and illustrated in reports of investigations of the Lake Koocanusa pool area by the Center for Northwest Anthropology (Thoms 1984; Thoms and Burtchard 1987). Reeves (2000) also describes point styles characteristic of various phases in the Glacier Park and northwestern Montana areas.

Twenty (n=20) projectile points and projectile point fragments were recovered during the 2000 investigations at Rainy Creek (Figures 40 and 41). Of that total, four of the specimens were found during monitoring of asbestos remediation, heavy equipment stripping of the south side of Rainy Creek (Figure 41). Six (n=6) specimens recovered during hand excavation were too fragmentary, or were in too poor condition, to reliably type (Figures 40b, c, d, f, k, and p). Only one projectile point, a fragmentary base (Figure 40p) was found below Level 4 (30-40cm BS) and it was recovered from Level 7 (60-70cm BS) of unit S-5 on the T1 terrace.

Typeable projectile points, most likely to be of the earliest age of specimens recovered from Rainy Creek, were all found in Level 4 (30-40cm BS) in excavation units placed on the alluvial fan (Figures 40l, m, and n). Two of these specimens (Figures 40l and n) are corner-notched, with straight bases and appear to fit points attributed to the Kavalla Phase by Roll (1982:5.12-5.13; Type 4). These specimens would also fit in the range of characteristics described by Reeves (2000) for the Pelican Lake Phase/Blue Slate Canyon Subphase and in the Harder Phase of the Lower Snake River (Leonhardy and Rice 1970).

One specimen recovered from 42cm below surface in backhoe Trench KDC-2 (Figure 40o) is nearly identical to Roll's (1982:5.13) Type 6, which he also attributes to the Kavalla Phase. Singleton (1982:I.20) describes Type 6 points as long and narrow, stemmed, with convex to straight bases, and acute-angled shoulders. The Rainy Creek specimen is not classically stemmed but seems to exhibit technologic characteristics of both corner-notching and side-notching.

One specimen recovered from Level 4 of unit S-1 (Figure 40m) is presently viewed as a typological anomaly. It is stemmed with a double set of shallow side-notches or serrations. The base is concave and the body form appears to be ovate rather than triangular. The blade edges are excurvate. By the time this report was completed, a Plains or Intermountain area typological analogue for this specimen was not found. Stratigraphic position of this specimen would suggest it associates with the Kavalla Phase/Pelican Lake Phase/Blue Slate Canyon Subphase or Choquette and Holstine's (1980) Inissimi Complex.

The single projectile point recovered from Level 3 on the alluvial fan came from unit S-6. Some may characterize this specimen (Figure 40j) as falling within the range of corner-notched varieties. However, it appears to have been notched upward from the base creating a narrow stem and barbed shoulders. Body form is triangular. In general form, this specimen appears more similar to Columbia Valley Corner-Notched varieties (Caldwell 1960; Roll 1974:100, 103) of the Pacific Northwest. The point also is similar to the range of points associated with the Harder and Piqunin Phases of the Lower Snake River (Leonhardy and Rice 1970). Analogues among illustrated points of the LAURD and CAN projects for this unusual specimen were not observed in those reports. Plateau and Pacific Northwest points mentioned above all associate with the Late Prehistoric Period, generally within the last 1500 years.

Specimens recovered from Level 2 in units placed on the alluvial fan all appear to associate with the Late Prehistoric Period. Two of the specimens (Figures 40f, g) may not actually represent project points. Specimen f could be a bifacial cutting or perforating tool although its thinness is more typical of projectile points. Specimen g is a triangular unnotched form that is larger than projectile points or projectile point "blanks" typically associated with late prehistoric times in the Plains and Intermountain areas. The overall form of specimen g is consistent with triangular unnotched points commonly found in Late Prehistoric occupations of the region. Specimen e (Figure 40e) is the base of a point with shallow side-notches set low on the blade. This specimen is consistent with characteristics described for Avonlea Phase in the Plains sequence (Reeves 1983; Frison 1978/1991), Roll's (1982) LAURD area Warex Phase, Reeves' (2000) Crandell Mountain Subphase (local equivalent of Avonlea), and Choquette and Holstine's (1980) Transitional period and the Akiyinek Complex. Roll (1982) suggests a temporal range of A.D. 500-1200 for the Warex Phase while Reeves (2000) suggests a range of about 1600 to 800 BP (radiocarbon years ago) for the Crandell Mountain Subphase.

An unnotched specimen (Figure 40h) is rather thin and well-flaked. Unnotched forms of Avonlea/Warex/Crandell Mountain are recognized by Reeves' (2000) but are also found in subsequent late prehistoric times and persist in the record up to protohistoric to historic times. Generally, unnotched forms from post-Warex times are thicker and are not as finely crafted as those from Warex/Avonlea times. The Rainy Creek specimen (Figure 40h) appears to be more finely crafted and thinner than later triangular unnotched forms and is therefore attributed to the Warex/Avonlea phase.

The last of the Level 2 points (Figure 40i) is a specimen that has been substantially reworked with resharpening flake scars apparent over the entire specimen. This specimen exhibits general characteristics of Late Prehistoric points but does not exhibit classic characteristics of a particular phase. It fits within the range of characteristics for Roll's Stonehill and Yarnell Phases or Reeves' Besant/Waterton River Subphase and his Old Women's/Tobacco Plains phases. It appears that the specimen originally had side-notches placed low on the blade but as mentioned reworking of the point has altered some of the original characteristics.

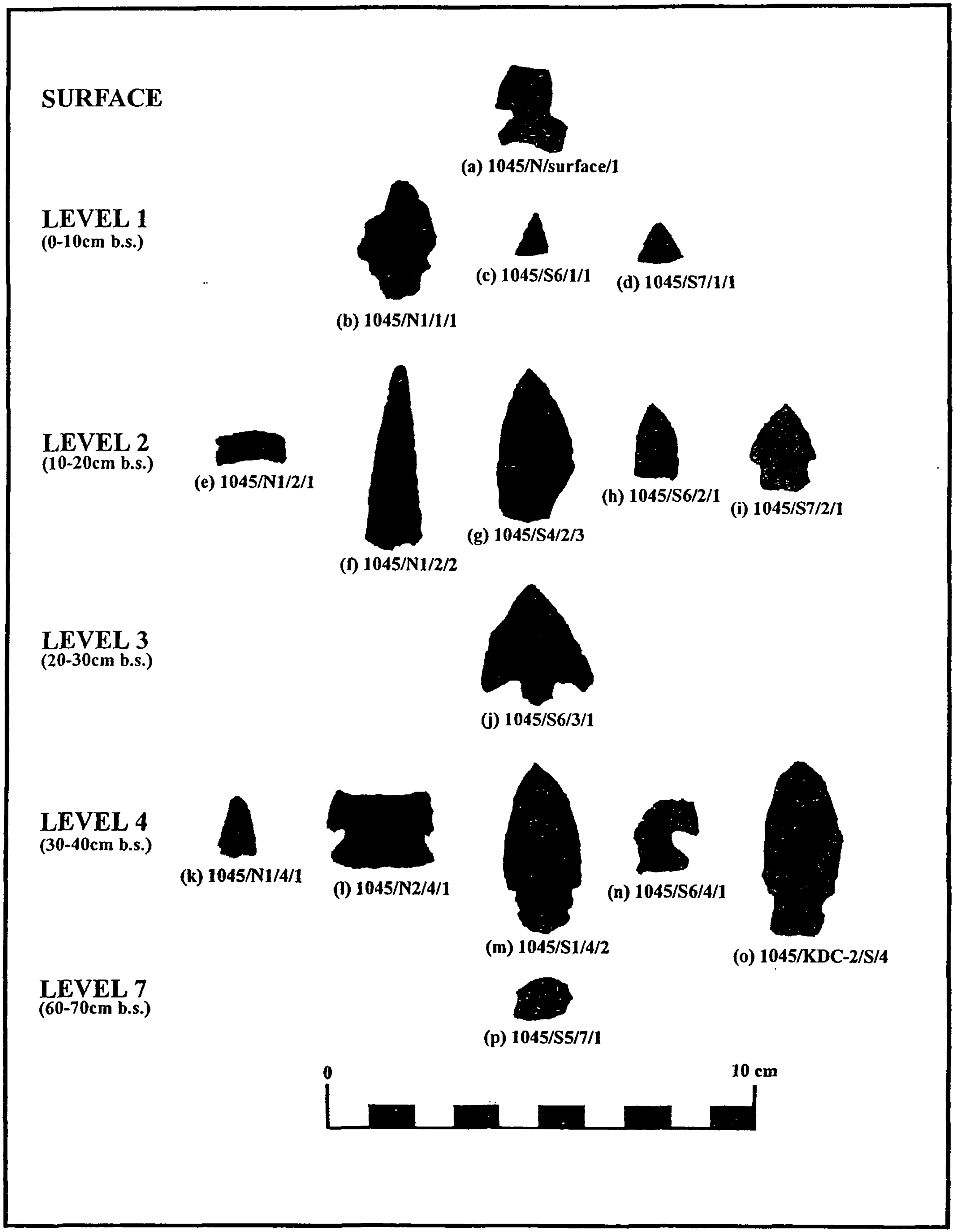


Figure 40: Projectile points arranged by level from 24LN1045.

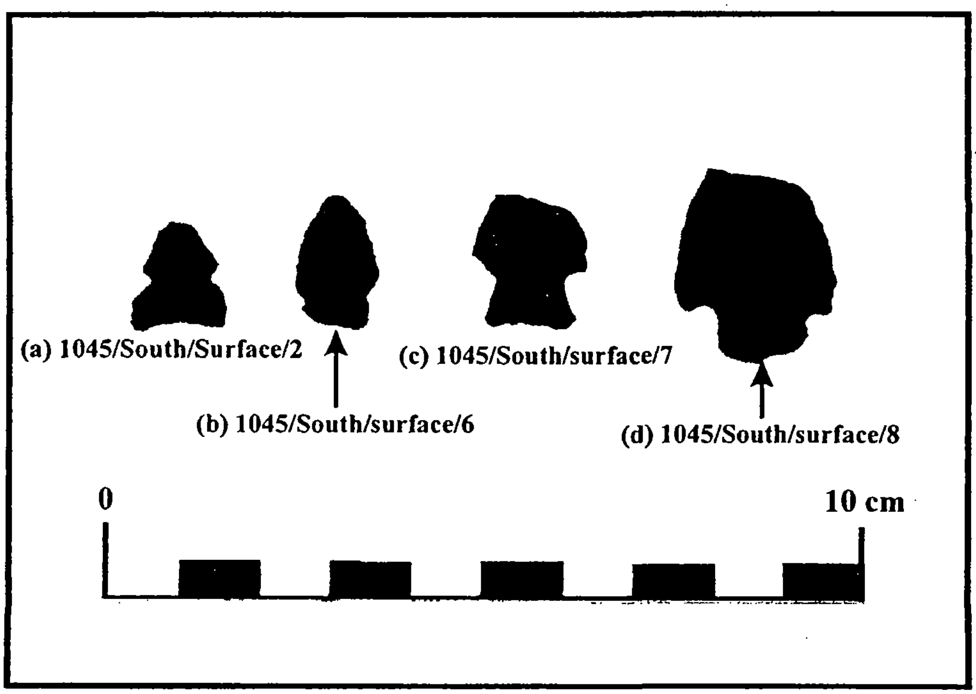


Figure 41: Projectile points found on disturbed/striped surface at 24LN1045.

All point specimens (Figures 40b, c, and d) recovered from Level 1 in alluvial fan units are simply too fragmentary to classify.

The single projectile point (Figure 40a) recovered from the site surface in an undisturbed area on the north edge of the alluvial fan (north side of Rainy Creek) also exhibits characteristics from two late prehistoric phases. One blade edge of this fragmentary specimen has been damaged (broken) while the other is in intact. The intact side exhibits a corner-notch slightly up from the base. This characteristic would tend to associate it with the Warex/Avonlea Phase where corner-notched forms are described from the LAURD project (Roll 1982: 5.17-5.19). The opposite edge retains a portion of the notch, which appears to be decidedly side-notched. This notch also appears to have been placed higher on the blade than is typical for Avonlea/Warex specimens and is more reminiscent of Roll's (1982) Yarnell Phase points or Reeves' Old Women's Phase/Tobacco Plains Phase. Temporal range for Yarnell/Old Women's/Tobacco Plains points is A.D. 1000 – 1800.

Four projectile points (Figure 41a, b, c, d) were recovered during monitoring of heavy equipment stripping of an area on south side of Rainy Creek on the Parker property. These specimens were not found in context but came from a stripped zone extending from surface to about 24" below surface. Two of the specimens (Figure 41a, b) are side-notched arrow points and likely associate with the Yarnell/Old Women's/Tobacco Plains phase. The other two specimens (Figure 41c, d) are corner-notched and likely associate with the Kavalla/Pelican Lake/Blue Slate Canyon phase.

In summary points representative of the Kavalla/Pelican Lake Phase, the Warex/Avonlea Phase, and the Yarnell/Old Women's Phase were recovered from Rainy Creek. Two anomalous points were also found with one reminiscent of the Harder Phase points of the Lower Snake River area or Columbia River Corner-Notched variety. Typological analogues for the other anomalous point from Rainy Creek were not found during research for this report.

MATERIAL CULTURE CONTENT AND TECHNICAL ANALYSES

By
Stephen A. Aaberg, Patrick Walker-Kuntz, and Chris Crofutt

Introduction

The material culture record from 24LN1045 includes chipped stone artifacts, ground stone artifacts, one bone artifact, butchered animal bone, heat-altered rock (including two formal features) and historic artifacts. A variety of analyses were undertaken on these materials. All materials were catalogued and were described in metric and non-metric terms (Appendix B). Descriptions and analyses of artifactual remains are presented below.

Chipped Stone Artifacts
*(see Appendix B for metric and non-metric descriptions)

Archaeologists classify all stone artifacts that are produced by flaking or chipping as chipped stone. The study of chipped stone from archeological collections has been augmented with studies of stone tool manufacture and use among living aboriginal groups, as well as with experiments conducted to replicate artifact forms. These kinds of studies confirm that, in their observable, measurable, physical attributes, chipped stone artifacts retain evidence for the circumstances surrounding their manufacture and\or use. To interpret the messages encoded in chipped stone artifacts, it is necessary to understand the processes involved in making and using stone tools, beginning with the selection of the raw material.

Since rock varies in its suitability for stone tool manufacture, particular varieties are sought for this purpose. Workable quality stone may be available near a site, or may have to be obtained from distant sources. Raw stone may also occur in the form of cobbles transported by water, or as outcrops or veins in bedrock. Rolled and smoothed by water, cobbles develop a rounded surface called "cortex". Chunks of bedrock may develop a discolored exterior surface from exposure to air, sun, and water. This surface is referred to as a "rind".

The selection of a piece of raw material for tool making often begins with "testing" the piece, by removing a portion of the rind or cortex, to look at the unweathered interior and the pattern of fracture. Materials most desirable for tool making are those that have conchoidal fracture, the type of "concentric ring" fracture exemplified by glass. This type of fracture is relatively predictable, and can therefore be controlled by carefully applied force. Materials with conchoidal fracture can be worked to produce extremely sharp edges. The finer the crystalline structure possessed by a rock, the more closely its fracture pattern approximates glass, and the (generally) easier it is to work to produce an intended result. Materials such as this are generally more favored for tool making.

Obsidian is volcanic glass, and therefore completely lacks crystalline structure. Obsidian breaks into pieces with edges that are razor-sharp, but which dull relatively quickly with use. Obsidian is so responsive to directed force that it can require great skill to make a finished tool.

Stone which has micro- or crypto-crystalline structure, like cherts and chalcedonies, also has conchoidal fracture. Since chert can form under several different sets of geological conditions, a great deal of variation exists between cherts from different geologic formations. A high quality chert can be broken to produce sharp, relatively durable edges. Chert is also somewhat less responsive than obsidian to directed force, and can therefore be more "forgiving" to the less-skilled tool maker.

Fine-grained macro-crystalline metamorphic rocks, like quartzite, can also make desirable raw materials for making stone tools.

The process of reducing a selected piece of raw material to a basic tool shape (preform), and forming it into a finished tool, involves the purposeful and systematic removal of bits of stone from a core (a process which can be compared to sculpting a figure from stone). This process is accomplished through percussion (with a hammer of some sort - stone, bone or antler) or the application of pressure (antler tines or sharpened bone).

If found suitable for tool making, a tested cobble or chunk may become the core from which smaller pieces are detached. The detached pieces may themselves be selected for further reduction into tool form, or may be discarded as waste. The detached pieces, whether the intended result of a blow to a core, or the waste by-products of lithic reduction, are referred to as debitage, debris, or detritus. Debris/debitage/detritus are pieces detached at any stage in the manufacture process, from the core, or from a tool preform, during efforts to shape it into a finished tool.

Pieces of debris can be broadly divided into flakes and shatter, based on the morphological characteristics they display. Flakes are thin with thickness as their smallest dimension relative to length and width. Flakes have sharp edges which allowed for occasional use as cutting tools without further modification. In addition, every complete flake possesses the following features: 1) a surface identifiable as ventral (inside - relative to the core), and dorsal (outside - relative to the core); 2) an area, called a striking platform, where force was applied to remove the flake from the core; and 3) a bulb of force or bulb of percussion, which appears on the ventral surface as bulbs or rings radiating from the striking platform, produced as a result of the application of force.

Shatter refers to those pieces of debris which lack characteristic flake features. These pieces may be thin, but are characteristically blocky, or chunky, and have blunt edges. Shatter is the unintended by-product of lithic reduction. It often occurs when natural weaknesses in raw material prevents or interrupts the patterned distribution of force through what might otherwise have ended up being a flake. Shatter can be produced at just about any stage in the reduction process. Other than a general reduction in size and the amount of cortex, consistent morphological differences do not occur from one stage to the next.

In contrast to shatter, flakes vary in appearance from one stage of lithic reduction to the next. As common sense would suggest, flakes from initial stages are relatively large, and have relatively more cortex (or rind) on their dorsal surfaces. Flakes produced from testing a cobble will have most or all of their dorsal surfaces covered by cortex. Cortex is usually absent by the tool edge sharpening stage. Flakes produced from sharpening tool edges generally lack cortex, and can be nearly microscopic.

In addition, flakes will vary in the appearance of their striking platform and bulb of force, depending on how force was applied to detach them. In initial and intermediate stages of reduction, force is applied to the core or preform by striking it with another stone, or a baton of wood or antler. This is referred to as percussion technique. The final stages of shaping and sharpening tool edges require more exacting application of force. During this stage, flakes are driven off by directing pressure to the edge of the tool with hand held pieces of sharpened bone, wood or antler tine.

The amount of energy invested in tool making depends on a variety of factors including the proximity and availability of the raw material, and the kind of task(s) to be performed. As noted above, a tool can be nothing more than a sharp flake selected from among those driven off a core and utilized as is, or with minor edge modification. Knocking a few flakes of a core can be the most expedient way to quickly produce a tool for a specific task, especially if the raw material is abundant and close at hand. The limited energy invested in producing such flake tools likely resulted in their being viewed as tools of the moment which could be discarded after a single use.

Making a tool that can be used repeatedly generally requires more modification of the flake blank to produce edges that are stronger and more durable. Tools with edges such as these can be re-sharpened without sacrificing much of the tool surface.

Tools requiring greater energy investment are generally those which conform to certain consistent morphological forms, depending on the task(s) for which they are made. Some tools are termed formal by their visible, intentional form or shape and include such items as scrapers, gravers, drills or projectile points.

While a flake may have been produced with the intention of using it as a tool, it is not recognized as such in the archeological record unless it has physical evidence of that intention. Evidence takes the form of flake scars or use wear on an edge(s). Flaking was produced through the intentional modification of the edge (to make it stronger and/or sharper). Use wear is apparent on edges and appears as smoothing or abrading and/or crushing and is produced through actual use of the tool.

The manufacture of more formal tools involves the removal of many small flakes from the edge(s), often to the point of completely obscuring the form of the original flake "blank".

Chipped stone tools, regardless of the amount of energy invested in their manufacture, share several features in common. They have edges and they have surfaces or "faces". While the number of edges a tool can exhibit is virtually limitless, most chipped stone tools have only two faces (an exception might be a core that is used as a tool). On any tool, an edge with flake scars on a single face is called "unifacial". Unifacial edges are used mostly for tasks that involve scraping. An edge with flake scars on two adjacent faces is called "bifacial", and is used for cutting. A third kind of edge is actually a projection or a point, and may be used for perforating. A tool may have any or all three of these edge types. Most formal tools have only one type of edge, and are referred to accordingly, either as "unifaces" or as "bifaces". A drill is a type of formal tool that may have bifacial or unifacial edges, but the "working" edge is actually a point.

Various attributes of tool edges, including angle, and the shape and patterning of flake scars, can be studied to identify the intended function and actual use of the tool, the amount and intensity of use, and the kinds of surfaces the tool was used on (bone, hide, wood, plant, etc.). Many of these analyses require the use of high-power magnification to distinguish patterns of small flake scars, or even the residue from material on which the tool was used. The shape of the tool as a whole can be studied as an additional indicator of function, as well as an indicator of cultural or temporal association. Some kinds of formal tools, particularly projectile points, have features, like blade shapes and haft styles, that occur in combinations, to define recurrent "styles". Styles can be found to prevail in archaeological assemblages from certain time periods and/or culture areas.

The study of observable traits on individual chipped stone artifacts is the a critical first step that facilitates an analysis of the collection as a whole. The next step is to identify patterns. For example, patterns may occur in the representation of raw material types within and across classes of chipped stone artifacts. Patterns may also emerge from the ratio of chipped stone debris to finished tools. Patterns may also be apparent in the spatial distribution of raw material types or artifact classes, or in the association of chipped stone with other archeological material, like bone. Patterns like these can signify proximity to sources of lithic raw material, preference for certain raw materials, or prevalence of certain stages in the lithic reduction sequence. They can be used to distinguish activity areas, to verify observations made on individual tools and how they were used, and to identify the importance of stone tool manufacture and use relative to other activities. Patterns can be observed within a site, across several sites, or even across localities on a regional level. At any spatial level, patterns can appear as trends in the temporal dimension.

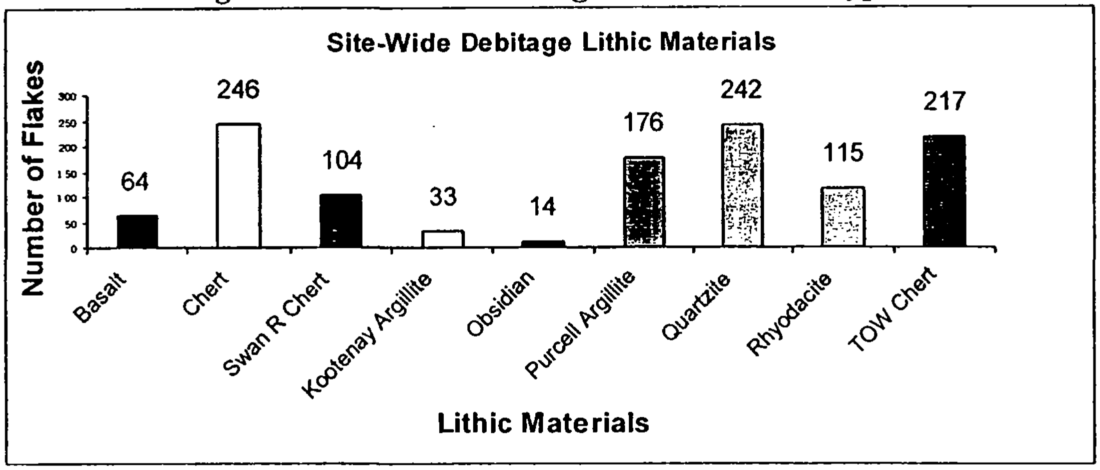
Lithology

Lithology is the study of rock types represented in the chipped stone artifact assemlage from a particular site. As mentioned above, rock types, or lithic material types, can be of local or non-local origin. Archaeologists often attempt to associate certain lithic material types with particular sources. While this is easily done with some rock types, such as obsidian (which has a chemical signature peculiar to specfic sources that can be identified with certain laboratory procedures), it is more difficult to accomplish with other rock types. Cherts and chalcedonies, in particular, present difficulties in identifying specific sources because they often form under the same circumstances in geologic formations that may be distributed across large geographic areas. To date very few cherts and chalcedonies, or cryptocrystallines as they are collectively called, have been determined to have a particular chemical signature. Yet archaeologists routinely ascribe particular sources to cryptocrystallines that have a particular color or range of colors and that have a particular stuctural appearance. Sometimes the inclusion of plant or animal fossils or fossil fragments in cryptocrystallines aid archaeologists in associating archaeological lithic artifacts to a particular source. Sometime logic plays a role in associating particular rock types to a specific source. For instance, grey to black glassy cherts commonly found in northwestern Montana and adjacent areas are often described as Top-of-the-World (TOW) cherts. The primary source for TOW chert is a quarry and outcrop of the material located in British Columbia. Although grey to black cherts are known to occur in many locations in North America, the proximity of the TOW quarry to northwest Montana logically leads archaeologists to associate grey to black cherts, found in area sites, to the TOW locality in British Columbia. In the analysis presented below, named rock types and their associations with particular sources are adopted from the body of archaeological literature for northwestern Montana and adjacent areas. However, it is entirely possible that some of the lithic materials found at Rainy Creek do not necessarily associate with specific sources ascribed to them by others.

Lithic Material Types at Rainy Creek

Locally available raw stone materials represented in the artifact assemblage from 24LN1045 include mudstones (particularly argillites) and quartzites. Analysis of debitage recovered from archaeological excavations at Rainy Creek, however, reveals a variety of likely non-local lithic raw material types, including basalt, Swan River Chert, Kootenay Argillite, obsidian, Purcell Argillite, rhyodacite, and Top-of-the-World (TOW) chert (Figure 42).

Figure 42: Site-Wide Debitage Lithic Material Types.



According to some archaeologists (Reeves 2000; Choquette 1987; Malouf 1956a, 1956b; and others), lithic material types are indicators of local and regional seasonal procurement of resources and patterns of movement. Lithic types provide insight into trade and exchange networks and population movements or changes through time (Reeves 2000:631). Reeves describes many lithic types found in northwestern Montana, some of which were found at the Rainy Creek site. The following definitions of lithic materialy types follow Reeve's descriptions.

Swan River Chert

Swan River Chert is a non-local, white to light pink, coarse to fine-grained material with white milky inclusions. This chert, named for a valley in Manitoba, is relatively common in the glaciated plains northeast of the project area. According to Reeves, use of Swan River Chert peaks in the Middle and Late Periods, and is particularly common in Avonlea Phase components in southern Alberta. In northwestern Montana, Avonlea and Old Women's Phase contain the most Swan River Chert (Reeves 2000:634). Our analysis finds that Swan River Chert use increases dramatically in Level 1, with somewhat smaller increases in Levels 4 and 6.

Top-of-the-World Chert

Top-of-the-World Chert is a chalcedony-like chert from Top-of-the-World Plateau in southeastern British Columbia. This material ranges from light gray to blue-gray, and dark gray to black, and has fossil inclusions. According to Reeves (2000), use of TOW chert increases during Pelican Lake, becoming dominant in Avonlea and is a "phase diagnostic" of the Tobacco Plains Phase (Late Side Notched, similar to Roll's Yarnell Phase). Reeves associates the quarry with the K'tunaxa, or Kutenai tribe. Our analysis shows that TOW Chert use peaks in Level 2 and drops in frequency in Level 1. TOW chert is dominant in the upper levels of unit S-5. Those levels likely associate with the protohistoric and historic K'tunaxa since a radiocarbon date of circa 320 BP was obtained from a cultural hearth about 17 to 24cm below surface and a glass trade bead was found in the first 10cm below surface.

Montana cherts include varieties originating in the Madison Limestone formations in central and southern Montana. In fact, chert is found in a wide range of geological formations in Montana, not just the Madison formation. Our use of Montana chert or cherts as a lithic type is meant to describe cherts and chalcedonic cherts with unknown sources. The wide variety of cherts included in this broad classification is not specifically assigned to any cultural/temporal associations. Reeves (2000) notes that Flathead and Kutenai knew certain quarries, and some specific quarries were used during Pelican Lake (Kavalla) times, but chert is not diagnostic marker. A shift in lithic material preference from basalt and quartzite to cryptocrystalline materials marks the second phase of Malouf's Late Hunter Period, just before historic times (1956a, 1956b). The current study shows Montana chert (chert) increasing steadily from the lower levels to the upper levels, particularly in occupations sampled on the alluvial fan.

Quartzite

A variety of quartzites originate in the area. In northwestern Montana area, quartzites appear in low frequencies in all time periods, particularly in Early and Early Middle Period components (Reeves 2000). Malouf found quartzite, as well as local basalt, common among Middle Prehistoric assemblages (1956a, 1956b). In our analysis, we found that quartzite use peaks early (in the lower levels) and decreases in relative frequency through time. Some of the site quartzites could be of local origin. Quartzite cobbles can be found in Kootenai River gravels and gravels from other area alluvial sources.

Kootenay Argillite

Kootenay Argillite is a light to dark green semi-translucent to opaque shale containing hemicones, or white semi-circles. This material exhibits step fracturing when flaked. Choquette (1984) suggests a single source for Kootenay argillite as occurring near the head of Kootenai Lake in British Columbia. However, Harrison and Campbell (1963) note the occurrence of green, dense, waxy-textured argillite with conchoidal fracture in the Wallace formation which is widespread in northwestern Montana including the project area. Although some suggest that Kootenay argillite is non-local, the geological reference cited above suggests otherwise. This material is described as rare, but may be associated with Pelican Lake, and occasionally with earlier and later complexes (Reeves 2000:640). At the Rainy Creek site, Kootenay Argillite use appears to peak early and decreases generally afterward with a minor peak in Level 3.

Purcell Argillite and Other Argillites

Purcell argillite is a common, fine-grained, dull, and opaque material in a range of colors. The most common form in the Kootenai River Valley is a banded green siliceous argillite (Reeves 2000). The Ravalli Group of geological formations is common and widespread in northwestern Montana and includes a variety of more coarse-grained argillites, with greater color variation (Kopp 1973; Harrison and Domencio 1973; Hrabar 1971). Purcell argillite likely associates with these formations and is likely of local origin. Reeves associates Purcell argillites with the Early and Early Middle Period. At the Rainy Creek site, Purcell Argillite use peaks in early and middle levels and becomes quite rare in the most recent deposits. The only stone core found during excavations at the Rainy Creek site is a Purcell Argillite core from Level 3 (30 cmbs) which probably fits in the late Kavalla/Stonehill phase (late Middle Period).

Although argillites represented in debitage are all fine-grained, some tools found at the site, particularly the stone disks/disk knives, were made from local, tabular pebbles of a more coarse-grained argillite. This stone is of local origin and is common in alluvial fan gravels as well as in the gravels of the Kootenai River. Argillite is a metmorphic rock formed of siltstone, claystone, or shale, that has undergone unduration. In theory, argillite can occur anywhere that metamorphosed shales, siltstones, and claystones are found. Argillite sources are common in northwestern Montana.

Basalt and Rhyodacite

Basalt is generally a poor material for chipped stone tool production. The finer varieties in northwestern Montana originate in the south and southwest portions of the state (Reeves 2000:641). The Clark Fork and Madison River Valleys contain workable basalt. Rhyodacite is a fine form of basalt quarried in southwestern Montana, including the Cashman Dacite Quarry (Baumler 1999). Reeves associates basalt and rhyodacite with Early and Middle Period occupations. According to Malouf (1956a and 1956b), local basalt use is associated with the "Forager" and "early Late Hunters", or Middle Prehistoric Period. Basalt is generally rare at the Rainy Creek site. Rhyodacite peaks in the lower levels and generally declines in use through time.

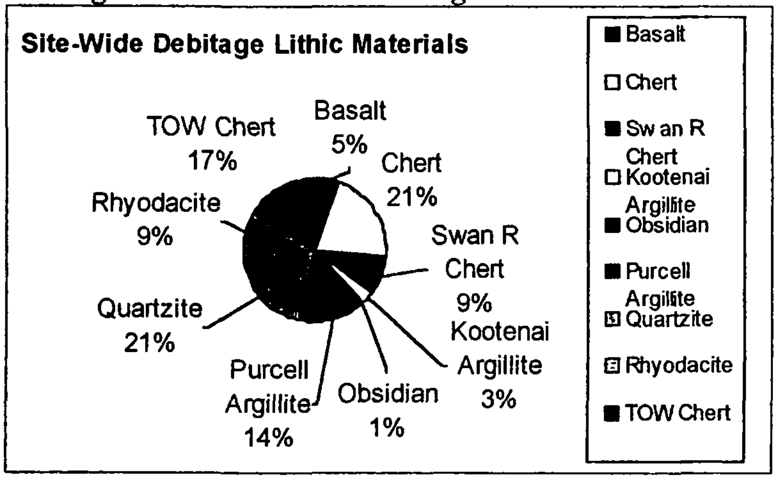
Obsidian

Obsidian is a generally black translucent volcanic glass. Only a few localities contain obsidian outcrops, and each source of the material has a unique and distinct chemical composition. Obsidian artifacts can be analyzed with an energy dispersive x-ray fluorescence spectrometer to determine the source location for the raw material. This information is useful in reconstructing prehistoric trade and/or movement. Obsidian is relatively rare in most areas but is often found, if in small amounts, even hundreds of miles from the nearest source. A few flakes of obsidian were recovered from the Rainy Creek site, with its use peaking in Level 2. Two obsidian artifacts from the Rainy Creek site were analyzed with x-ray fluorescence (Hughes 2001: Appendix C this report). Trace elements observed in the material indicate that one of the pieces originated at Obsidian Cliff in Yellowstone National Park, Wyoming, and the other came from Malad in southeastern Idaho, near the Utah border.

Patterns of Lithic Material Type Use

From the overall sample recovered from excavation units (n=1140), undifferentiated chert and quartzite are the most highly represented materials. Top-of-the-World (TOW) chert and Purcell argillite, and smaller amounts of rhyodacite, Swan River chert, basalt, Kootenai argillite, and obsidian follow in relative frequency (Figure 43). Comparative studies of the distribution of these materials include both vertical and horizontal spatial patterning. Interesting patterns emerge from the analysis of raw lithic material types found among the debitage.

Figure 43: Site-Wide Debitage Lithic Materials.



The relative frequency, or percentage of a given material per level, gives a picture of changing preference for, or access to, certain stone materials over time (the following figures illustrate percentages of particular materials from within each level). For example, the relative frequency of chert increases steadily, and dramatically, from lowest in Level 8 to highest in Level 1 (Figure 44). Swan River Chert also first appears in low frequency in Level 8, with two small frequency peaks in Levels 6 and 4, and a dramatic increase in Level 1. This suggests either a growing preference for cherts, or increased access to chert sources, such as quarries, through the history of occupation of the Rainy Creek site.

Conversely, the use of quartzites drops irregularly over time, but very dramatically between Level 2 and Level 1. Rhyodacite use increases early on, peaking above twenty percent in Level 6, but then follows a general trend of decreasing use. These patterns indicate declining use of these coarser-grained materials over time (Figure 45).

Figure 44: Chert and Swan River Chert Debitage by Levels.

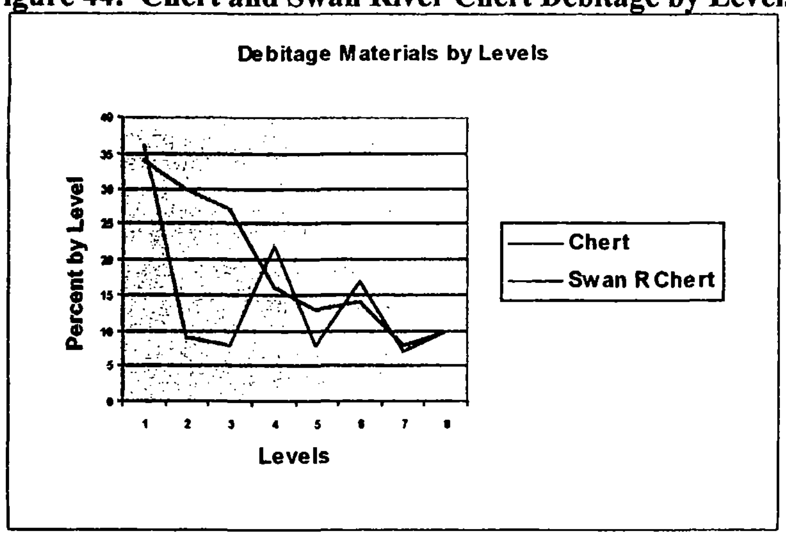
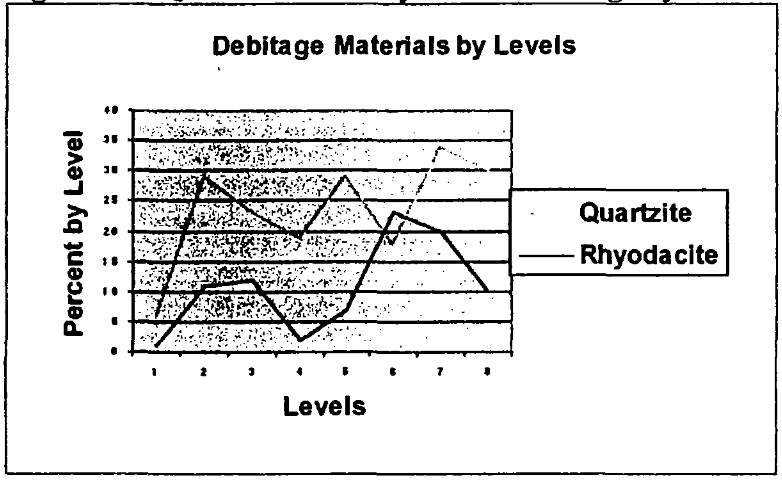
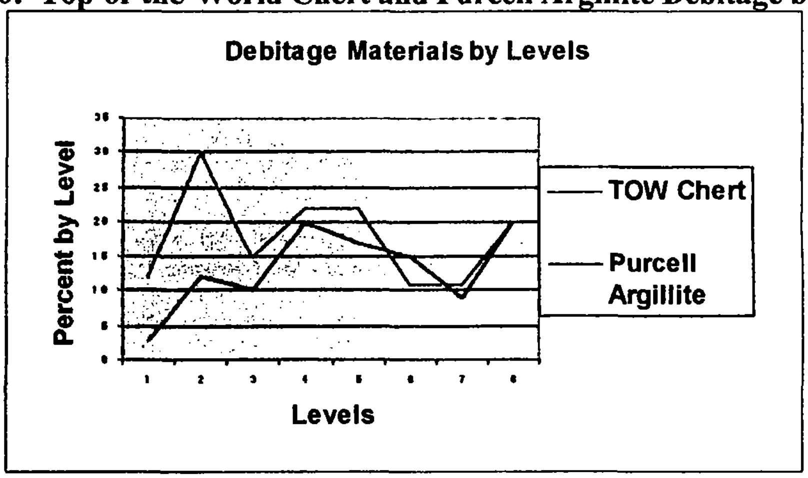


Figure 45: Quartzite and Rhyodacite Debitage by Levels.



Interestingly, Top-of-the-World Chert and Purcell Argillite share a strikingly similar pattern (Figure 46). Both of these material types begin in Level 8 with high relative frequencies and drop significantly in percentage in Level 7. Both TOW Chert and Purcell Argillite rise in frequency in the middle levels, Levels 4 and 5. The frequencies of these materials decrease sharply in Level 3. Purcell Argillite continues to decrease. However, Top-of-the-World Chert jumps in relative frequency to thirty percent of Level 2.

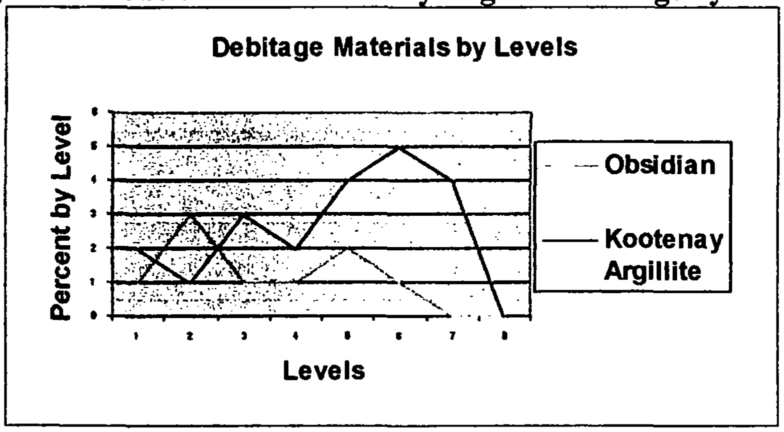
Figure 46: Top-of-the-World Chert and Purcell Argillite Debitage by Levels.



The two least represented material types are Kootenay Argillite and Obsidian, and they have a nearly inverse relationship (Figure 47). Kootenay Argillite is absent in Level 8, but rises quickly in frequency, peaking at 5% in Level 6. This material then decreases in overall use, with small increases in Levels 3 and 1. Obsidian is absent in Levels 8 and 7, rising from 1% in Level 6 to 2% in Level 5. The relative frequency of obsidian drops back down to 1% through Levels 4 and 3. During this low period of obsidian use, Kootenay Argillite experiences its second peak in use. Conversely, as obsidian experiences an upswing in its representation, to its highest peak

(3%) in Level 2, Kootenay Argillite drops below (1%) the relative frequency of obsidian for the first time. Obsidian drops again in Level 1 to 1%, while Kootenay Argillite increases to 2%.

Figure 47: Obsidian and Kootenay Argillite Debitage by Levels.



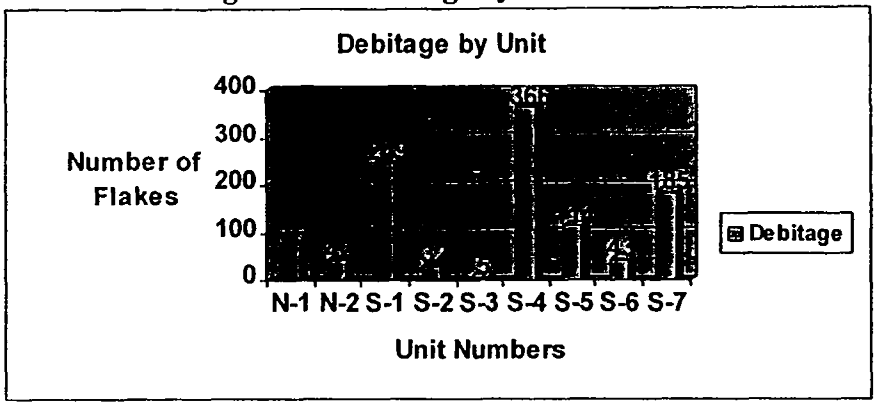
Lithic Debitage Distributional Analysis

The most abundant (n=1112) chipped stone artifact type from hand excavated units at the Rainy Creek site is debitage, the by-product of chipped stone tool production. As an artifact class, debitage is unique because it was generally created on-site and left where it was created. Therefore, debitage analysis can be an important indicator of site activities. Analyses of the distribution of debitage were undertaken in attempts to discern patterns indicating activities and/or historical developments related to the site. The analyses consist of five basic studies, including: 1) horizontal distribution of debitage (i.e., across the site), 2) vertical distribution of debitage in levels, 3) patterns of raw lithic material frequency horizontally across the site, and 4) patterns of raw lithic material frequency vertically through levels, and 5) size grade analysis of flakes.

Debitage Per Unit

Analysis of debitage densities per excavation unit illustrates the horizontal distribution of debitage across the excavated portions of the site (Figure 48). Figure 48 only represents debitage recovered from excavation units, not from disturbed surfaces or trench fill. The highest densities of debitage are from excavation Units S-1 and S-4, and to a lesser extant, S-7 (Figure 5). All of these units are located south of Rainy Creek, which cuts through the approximate center of the site. Units S-1 and S-4 are adjacent to each other and are located near the south bank of Rainy Creek near its confluence with the Kootenai River. These two units yielded 615 individual lithic flakes, approximately 57% of the total excavated debitage. Unit S-7 is located on the southern edge of the site. This unit contained 185 debitage flakes, or approximately 17% of the site total.

Figure 48: Debitage by Unit.

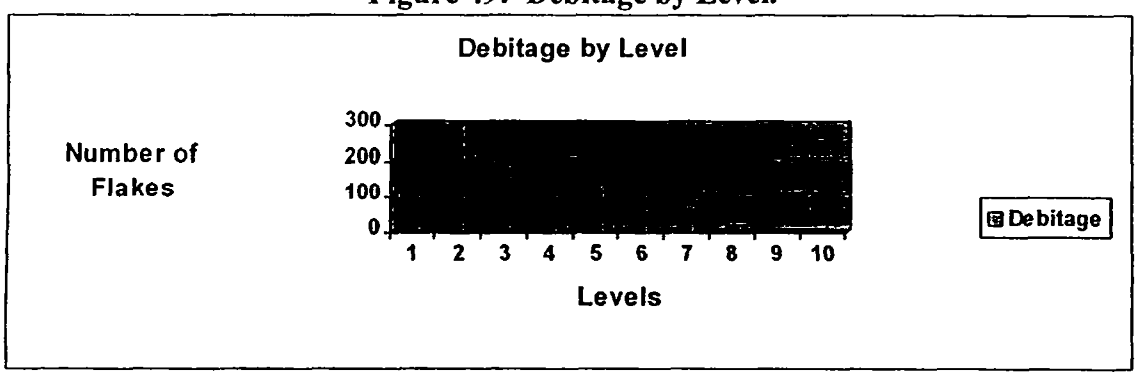


The two separate areas of high debitage density, represented by Units S-1 and S-4, and Unit S-7 (Figure 5), indicate a definite patterning of stone flaking activity. These same areas also contained the highest amounts of heat-altered rock (see below). The south bank of Rainy Creek, near its confluence with the Kootenai River, was certainly the location of intense chipped stone activity (area of units S-1 and S-4). The south edge of the site (area of unit S-7) was also intensely occupied, but to a somewhat lesser degree.

Debitage Per Level

Total distribution of lithic debris by excavation levels (Figure 49) across the site follows a general pattern similar to that of heat-altered rock by level (see section on heat altered rock below). The number of lithic flakes increases steadily from Level 10 upward to Level 2, and drops off in Level 1. A small decrease in debitage occurs in Level 4.

Figure 49: Debitage by Level.

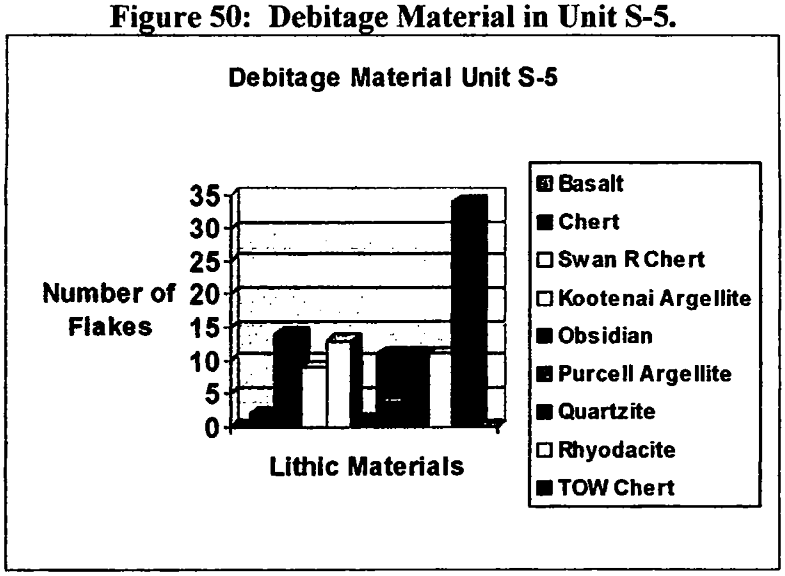


Temporal Lithologic Trends

Although the site stratigraphy is complex, gross stratigraphy is likely retained in portions of the site and groupings of the arbitrarily excavated 10cm levels may correlate generally to broad time periods. Most of the excavated units and trenches were dug into relatively old alluvial fan deposits. Three radiocarbon dates were taken from these alluvial deposits. The oldest and deepest radiocarbon date (ca. 3720 BP) was obtained from a soil sample taken from a paleosol at 120-130 cmbs in a backhoe trench. Two other radiocarbon dates from the alluvial fan deposits include a circa 2860 BP date from a backhoe trench paleosol at 80-90 cmbs and a circa 1810 BP date from a cultural feature at about 30 to 50 cmbs in a backhoe trench. As stated previously, most of the excavated units are located on these same alluvial deposits, so an approximation of time periods may be applied to the levels, i.e., the deepest levels (6, 7, 8, 9, and 10) probably date to the middle Middle Prehistoric Period, the middle three levels (3, 4, and 5) date to approximately the late Middle Prehistoric Period, and the top two levels (1 and 2) may be associated with the Late Prehistoric Period.

One excavation unit (S-5) was excavated into overbank deposits on the T1 terrace, beyond the limits of the alluvial fan. This unit contained younger deposits at deeper levels than found in the alluvial fan deposits. A hearth feature found in S-5 at 17-24 cmbs was radiocarbon dated to circa 320 BP. A protohistoric glass trade bead was also recovered from above the feature. The late date from this feature is expected from the relatively young overbank sediments. Interestingly, Unit S-5 contained an unusually high amount of Top-of-the-World (TOW) chert debitage (Figure 50). As stated earlier, Reeves considers preference for TOW chert to be a defining characteristic of the Tobacco Plains Phase (a local mountain adapted expression of Old Women's Phase), which dates from 200 to 800 years ago (Reeves 2000). Reeves associates the Top-of-the-World chert quarry with the historic K'tunaxa, or Kutenai tribe.

Figure 50: Debitage Material in Unit S-5.



Debitage Size Grade Analysis

The size of flakes is useful in determining patterns of manufacture for particular tool types fashioned on flakes. Size grade analysis also assists in interpreting what stages of tool manufacture were occurring at a site. The type of size-grade analysis used in this report follows that set forth by Ahler and Christensen (1983). In the laboratory, all flakes and flake tools were screened through size-graded mesh. Grade 1 (G1) is 1"-mesh which selects for flakes of one inch or larger. Grade 2 (G2) is ½"-mesh screen that selects for flakes between ½" and 1". Grade 3 (G3) is ¼"-mesh that selects for flakes between ¼" and ½". Grade 4 (G4) is 1/8"-mesh and selects for flakes smaller than ¼". Grade 5 (G5) flakes are any that are smaller than 1/8".

Size grades G3 and G4 flakes dominate the assemblage with 413 (38%) and 606 (51%) respectively (Figure 51). The G3 size grade flakes are dominated by quartzite, followed by Purcell Argillite, Top-of-the-World Chert, and chert. Grade size G4 flakes are mostly chert and TOW Chert, followed by quartzite, Purcell Argillite, and Swan River Chert. Only 2% of the debitage is size grade G5 (n=26). Most of these are TOW Chert and chert. The G1s and G2s constitute 9% of the total (95/1140). These are primarily quartzite, rhyodacite, and basalt.

The predominance of G3s and G4s indicates particular stone working activities. Most of the G3 flakes are bifacial thinning flakes, internal percussion flakes, and pressure flakes. The G4 flakes are primarily pressure flakes. Tool manufacture, finishing, sharpening, and maintenance would likely result in an overrepresentation of G3 and G4 flakes. Many of the G3 flakes are quartzite, while most of the G4 size flakes are cherts. Quartzites are locally occurring, and are therefore well represented in both the G2 and G3 size grades. Because this material is abundant, relatively early stages of reduction of quartzites can be expected. However, only two flake tools and one biface recovered in the excavations were quartzite, indicating the site inhabitants did not favor this coarse-grained material for finished tools. Cryptocrystallines were preferred for finished formal tools, such as projectile points, bifaces, and end scrapers. Quartzites were commonly used for expedient tools, which were produced with little pressure flaking. However, as indicated in Figure 52, Chert was the preferred material even for flake tools.

Figure 51: Debitage Size Grades at 24LN1045.

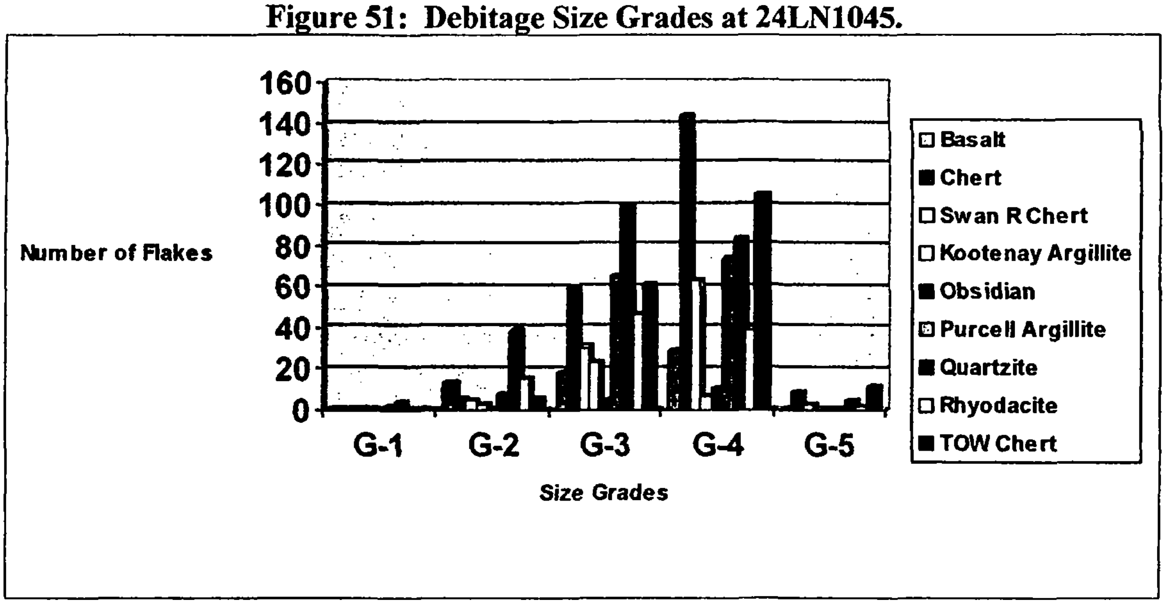
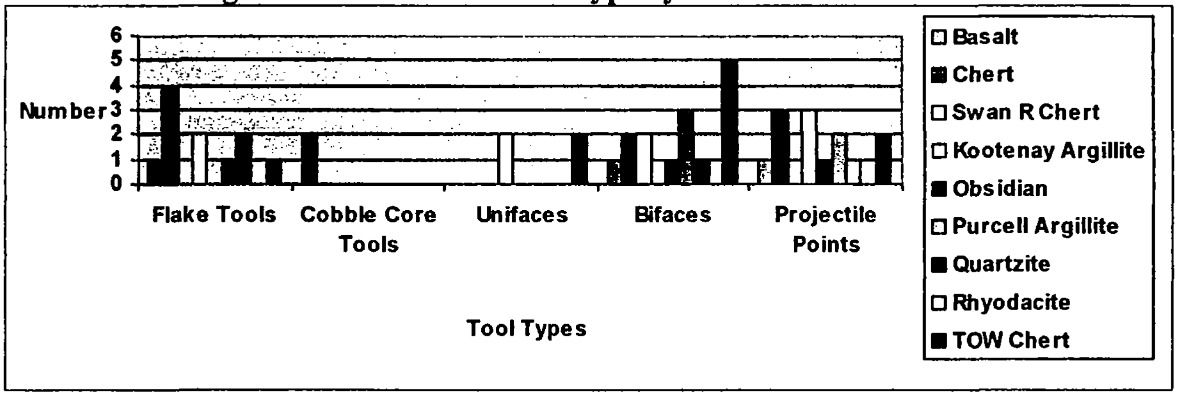


Figure 52: Lithic Material Type by Artifact at 24LN1045.



Chipped Stone Tool Analysis

Projectile Points

*see Table 2: Appendix B for metric and non-metric descriptions

Twenty (n=20) projectile points and projectile point fragments were recovered during the 2000 investigations at Rainy Creek (Figures 40 and 41). For a detailed description and typological discussion of those points see the section on Typological Crossdating presented earlier in this report (page 126).

Projectile Points and Raw Material Type

No single material type dominates the projectile point collection. Three are chert and three are Kootenay Argillite. Two are TOW chert and two are Purcell Argillite. One each is made of basalt, obsidian, and ryodacite. The two TOW chert points are from disturbed surface areas. One is similar to the style Reeves calls Tobacco Plains, and one appears be a shallowly side-notched late period point. The Kootenai Argillite points are both corner-notched, one from Level 4 (40cmbs) and one from the disturbed surface. According to Reeves (2000:419) and Roll (1982): Kootenay Argillite has a moderated frequency in Kavalla, as does TOW chert.

Bifaces

*see Table 3: Appendix B for metric and non-metric descriptions

Most of the functional tool categories and descriptors used in this report are self-explanatory. However, in describing non-projectile point bifaces, the authors use a serial classificatory scheme (Stages I-V) based on technologic or manufacturing stage. In this system, Stage I bifaces are bifacially reduced cores or blanks that are very grossly shaped by percussion flaking. Stage II specimens are early stage bifaces that have been further reduced and thinned by percussion flaking. Stage III specimens are intermediate stage bifaces with edge shaping by percussion (dominant) and some pressure flaking. Stage IV specimens are late stage bifaces that exhibit edge finishing in the form of pressure flaking (dominant) with some percussion flaking still evident. Stage V specimens are bifaces which have been completely finished and which exhibit pressure sharpening and resharpening (sometimes evidence of numerous stages of resharpening). Also included in this class are drills and unidentifiable fragments that could have functioned as knives or projectile points.

An examination of lithic tool types grouped by raw material type indicates that the most represented material among bifaces (5 of 16, or 31%) is TOW Chert. Although these artifacts are technically classified as bifaces, they appear to actually be projectile point fragments, primarily distal tip fragments (4 of 5). One of the point fragments is a base that resembles a slightly notched Avonlea point base. This point base is 15mm wide, suggesting possible use as an atlatl dart point, rather than an arrowhead. However, Avonlea points tend to be somewhat wider at the base than later arrow point styles. This point base may be a Warex phase point (Roll 1982). This point and three of the tips were found in the first 20cm below surface. One of the TOW Chert projectile point tips was recovered from Level 7 (70 cmbs). The tendency for TOW Chert to be found in the uppermost levels is consistent with the expectation that later time periods saw greater use of TOW Chert materials.

Other bifaces include three Purcell Argillite artifacts (Figure 53). One (DP/KDC-1/South/2) is a Stage III biface fragment recovered from the deep paleosol in Trench KDC-1 (Figure 53a). The tool is 4cm long by 1.5 cm wide and is lanceolate in shape with one acute end and one rounded end. Another biface (1045/South/Surface/5), found on the surface, is a complete Stage I biface made of Purcell Argillite (Figure 53b). This tool is triangular with an acute distal end and obtuse lateral sides. This artifact measures 4cm long by 2.5cm wide. A third Purcell Argillite biface (1045/N2/10/1) was recovered from Unit N2 on the north edge of the site in Level 10 (100 cmbs). This artifact is a complete Stage I biface, is ovate in shape, with one acute end and one rounded end (Figure 53c).

Two chert bifaces were recovered (Figure 53). These include one drill (1045/S1/1/1) and one lanceolate biface (1045/N1/4/1). The drill is finely made from a dark brown chert and measures 3.9cm long by 1.5cm wide at the base (Figure 53d), found in Level 1 of Unit S1, indicating Late Period use. The other chert biface is a small Stage IV fragment made of a reddish brown chert (Figure 53e). The fragment has one acute end and one rounded end and straight edges, and appears to be the distal tip of a larger artifact. It measures 1.4cm by .45cm, and was found in Level 4 of N1, indicating Middle Period, possibly Kavalla, use.

Two Swan River Chert bifaces were recovered (Figure 53). One of these (1045/S1/4/1) is a Stage IV midsection fragment with a transverse break (Figure 53f). The fragment, found in Level 4 (40cmbs) of Unit S1, is triangular with an acute distal end and obtuse blade edges. The other (1045/TRF/S2/1) is a Stage II biface fragment found in trench fill near Unit S2. The fragment is an acutely bipointed lanceolate biface with a longitudinal break (Figure 53g).

One basalt biface (Figure 40f), possibly a broken and reworked projectile point, was recovered (1045/N1/2/2). The base and edges exhibit resharpening flakes. In its present form this biface has the appearance of a complete Stage V triangular to lanceolate body form. This tool is 4.3cm long and 1.4cm wide at the base and is relatively thick in the center. This artifact was recovered in Unit N1 in Level 2 (20cmbs). Although basalt use may be considered more common in Middle Period assemblages (Malouf 1956; Reeves 2000), this tool is probably associated with the Late Prehistoric period.

One obsidian biface (Figure 40b) was found in Level 1 (10cmbs) of Unit N1 (1045/N1/1/1). This biface is a Stage II fragment that may be a projectile point. In its present

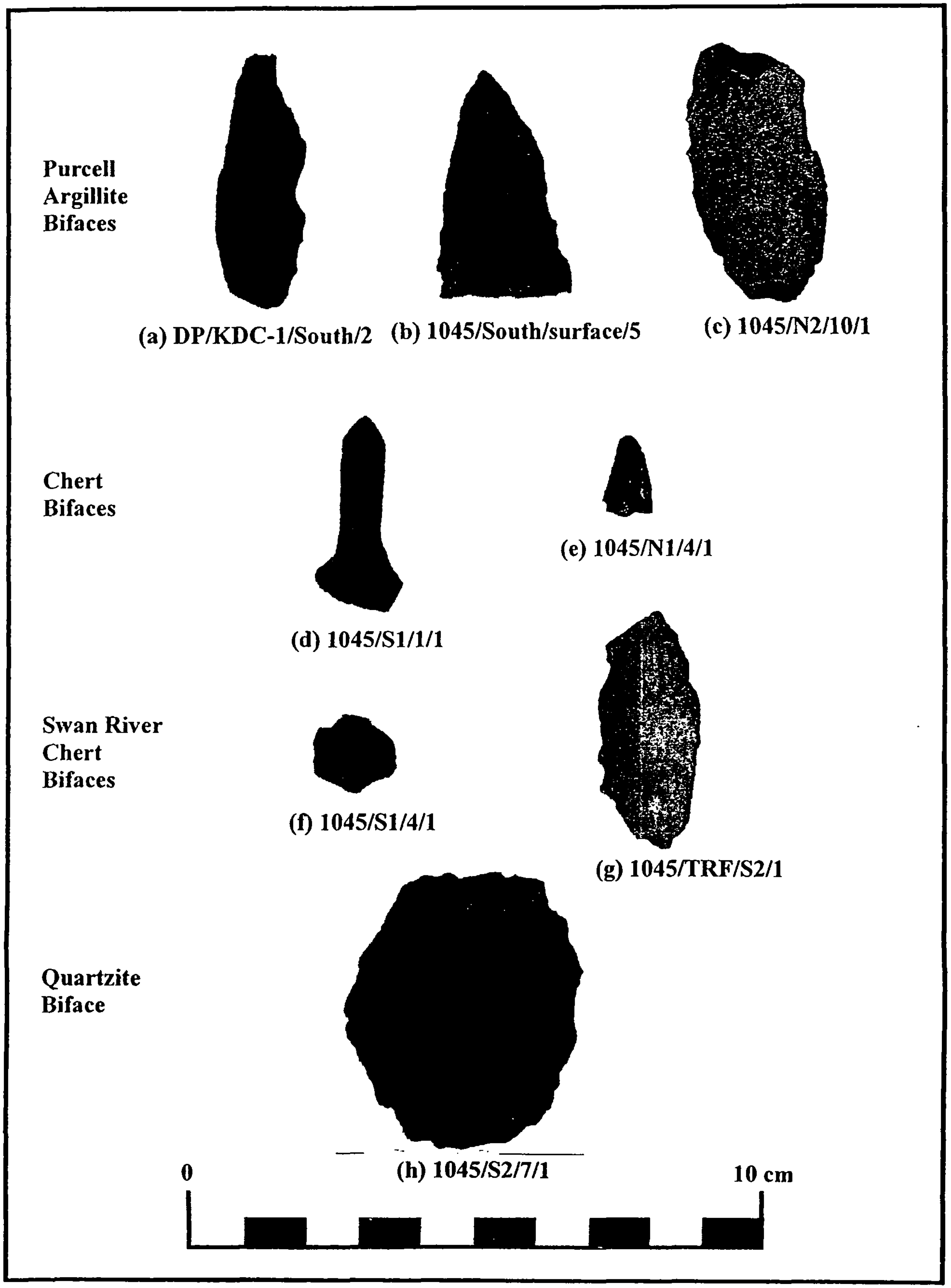


Figure 53: Bifaces from 24LN1045.

form this biface is 2.8cm long by 1.9cm wide. This artifact was submitted to the Geochemical Research Laboratory for x-ray fluorescence analysis. Trace element analysis indicates the source for the obsidian as Obsidian Cliff, Wyoming (Yellowstone National Park).

A single quartzite biface (Figure 53h) was found (1045/S2/7/1). This tool is a complete Stage I acutely bipointed ovate biface with excurvate edges from Level 7 (70cmbs) in Unit S2. This biface measures 5.1 cm by 4.9 cm. Level 7 is one of the deepest culture-bearing levels in hand-excavated units at Rainy Creek. As stated earlier, Malouf (1956a, 1956b) and Reeves (2000) find quartzite more common among Middle Prehistoric assemblages than earlier or later periods. The depth at which biface was found (as is also the case with most of the quartzite debitage) appears consistent with this assertion.

Unifaces

*see Table 4: Appendix B for metric and non-metric descriptions

This class of artifacts includes scraping tools (side scrapers and end scrapers) and cutting tools. Four unifaces (Figure 54) were recovered during investigations at Rainy Creek. These include two TOW chert scrapers found on the surface (1045/South/Surface/3 and 1045/South/Surface/4). The first is an irregular end scraper with finished distal and lateral edges (Figure 54a). The second is a single edged scraper fragment with an acute working edge possibly used for cutting and scraping (Figure 54b).

The third uniface is a Kootenai Argillite knife (1045/S1/3/2) formed from a long flake and worked along all the edges on both sides (double-beveled)(Figure 54c). This is very similar to Tom Roll's "argillite knives" of Kavalla and later phases (1982). Immunological analysis of this knife tested positive for plant residue from the Capparaceae family (caper family).

The fourth uniface (Figure 44d) is a small Kootenai Argillite end or thumb scraper (1045/TR3/1) that is well finished on the dorsal surface. It exhibits a steep, distal working face. This artifact was recovered from Trench 3 at a depth of 20 cm below surface. Immunological analysis tested negative.

Flake Tools

*see Table 5: Appendix B for metric and non-metric descriptions

There are two basic classes of flake tools: modified, or retouched flakes, and utilized flakes. Modified (retouched) flakes have patterned or unpatterned retouch flaking along one or more edges. The limited flaking, however, has not resulted in major modification to the shape of the flake. Utilized flakes show signs of use-wear but no intentional modification.

Only 12 lithic flake tools (Figure 55) were recovered from Rainy Creek. Flake tools were made from a variety of materials, but most frequently chert (4/12 or 33%). All but one are non-cortical. One basalt flake tool (1045/South/Surface/1) has cortex present (Figure 55k). All of the flake tools are retouched flakes with modification. They were found widely distributed through the levels.

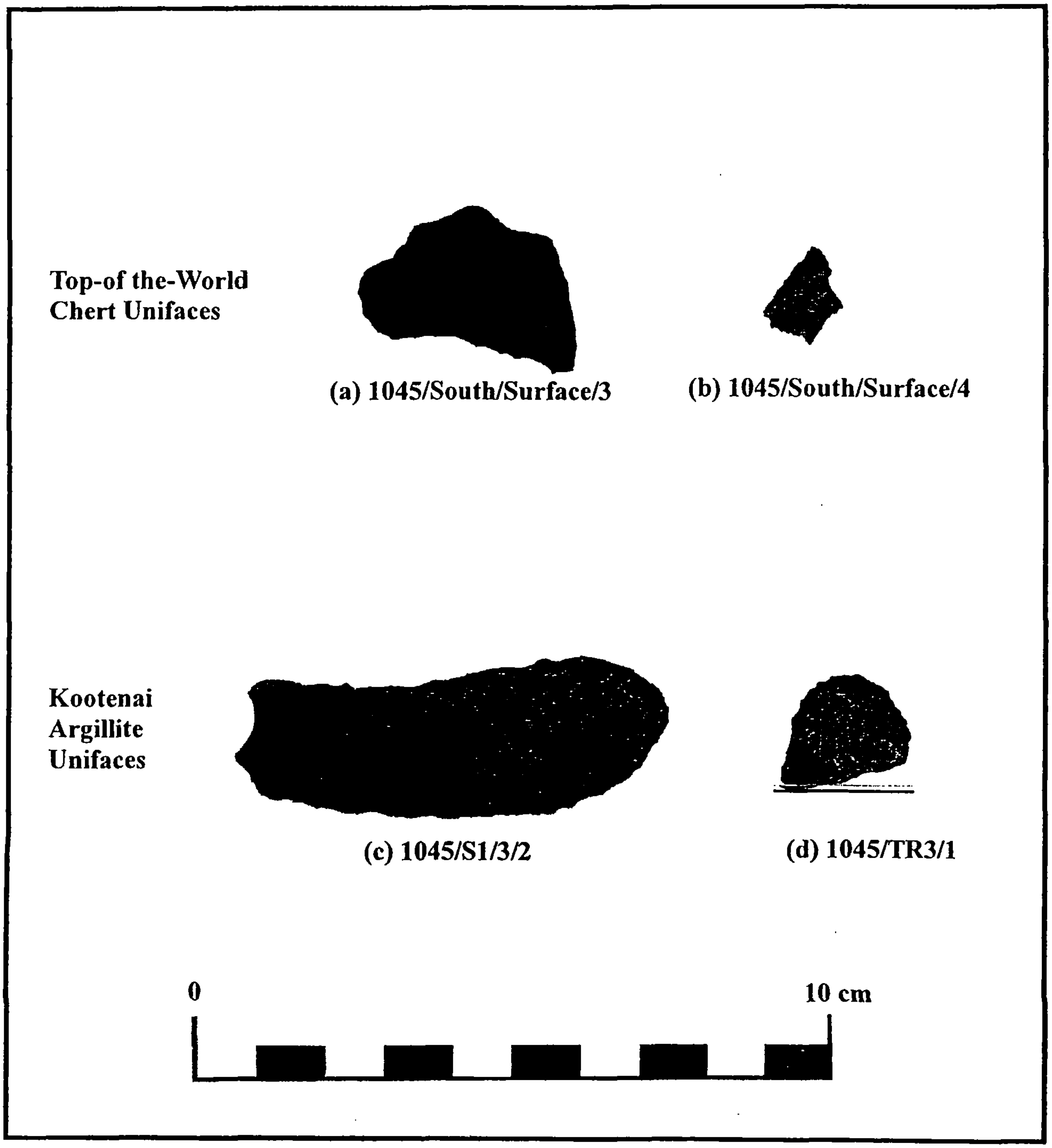
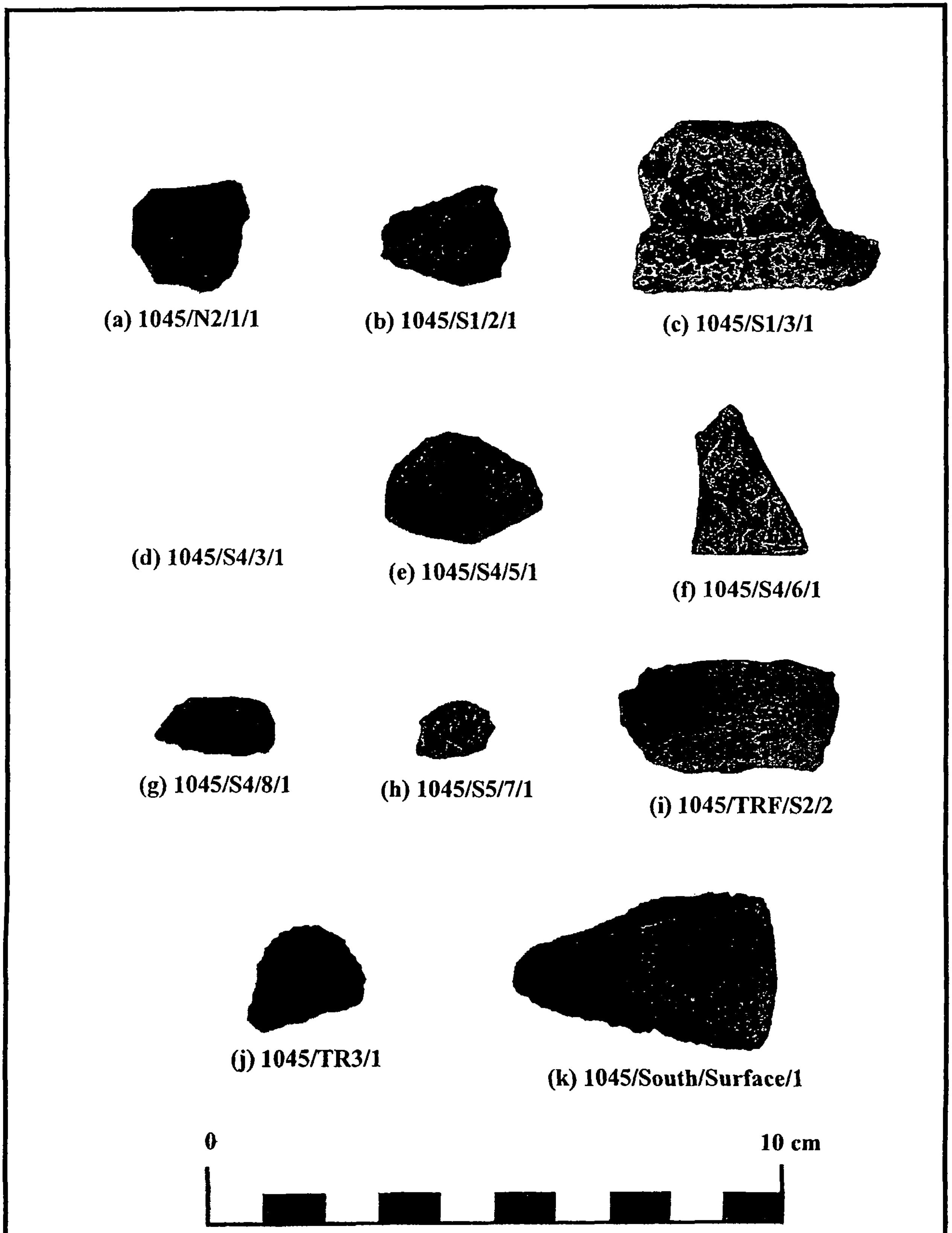


Figure 54: Unifaces from 24LN1045.



*** Note one flake tool not pictured.**

Figure 55: Flake Tools from 24LN1045.

Cores and Core Tools

*see Tables 6 and 7: Appendix B for metric and non-metric descriptions

The only stone core (1045/S1/3/3) found during excavations at the Rainy Creek site is a Purcell Argillite specimen (Figure 56a) from Level 3 (30 cmbs). It probably associates with the late Kavalla/Stonehill phase (late Middle Period).

Two cobble core tools formed by direct hand percussion were found at Rainy Creek (Figure 56b and 56c). Both of these are basalt and both have a single, transverse, unifacial, working edge. One (DP/KDC-1/South 1)(Figure 56b) was found in a deeply buried paleosol, dated to approximately 3700 years ago, that lay 124-150cm below surface. The other (1045/S7/1/2)(Figure 56c) was recovered from the first level (10cmbs) in Unit S7.

Chipped Disks

*see Table 8: Appendix B for metric and non-metric descriptions

A total of 30 disks were found at the site, 29 in excavation and one from Trench 3, making chipped disks the most common artifact type from the Rainy Creek site after debitage. These small tools are oval to square or rectangular in outline and have been formed by bifacial retouch of sheets/slabs of local argillaceous shale, sandstone, metamorphosed schist or slate (Figures 57 and 58).

Reeves states that "chipped disk argillite knives" appear during the Blue Slate Canyon Phase, or Kavalla Phase (2000:418). Reeves apparently equates Roll's "argillite knives" of Kavalla from the LAURD Project with chipped stone disks. However, Roll appears to be referring to a specific type of uniface formed from long flakes (1982:5.113-14). Roll's report does show pictures of what appear to be chipped stone disks identical to some found at Rainy Creek, but he has labeled them "notched pebbles", presumably used as net sinkers, although the illustrated disks have no notches.

Chipped stone disks are a quite common tool type found in the region, often found in Columbia Plateau sites and are more common than spall tools (Reeves 2000:418). One of the chipped stone tool types from the Koocanusa sites are these slab tools or chipped disks (Bussey 1977:61). Bussey suggests chipped disks were used to process fish and/or hides; and they could have served cutting and/or scraping functions. Reeves apparently submitted some chipped disks for blood trace analysis and has verified Bussey's assertion, apparently with positive animal antisera results (Reeves 2000, Appendix A: Section 14). Two stone disks from the Rainy Creek assemblage were submitted for immunological analysis but antisera tests were all negative. According to Reeves, "Flat skipping pebbles of Grinnell (local) Argillite are common along the streams and lakes. They are the common source for the notched/grooved line/net sinkers as well as the bifacially chipped rectangular disks found in Blue Slate Canyon Subphase sites" (Reeves 2000:261).

The chipped disks recovered from the Rainy Creek site are probably not net sinkers. Only three actual notched net sinkers were found (Figure 59), two from the surface (Figure 59a and 59b) and one from trench fill at the south end of the site (Figure 59c). Comparing these notched pebbles with the chipped disks, an obvious difference in morphology is immediately apparent. The net sinkers/notched pebbles are also much heavier than the chipped disks. An

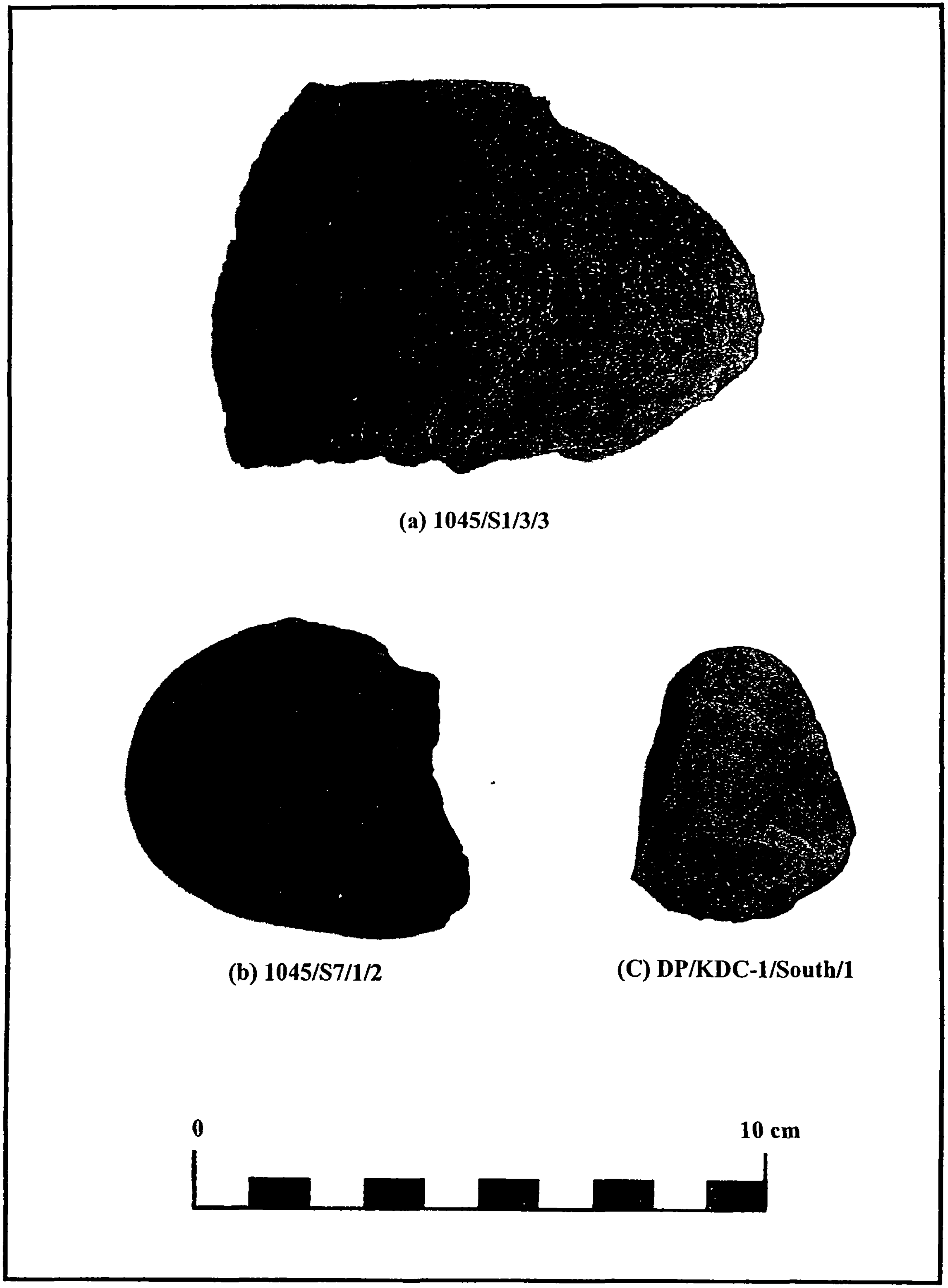


Figure 56: Core and Core Tools from 24LN1045.

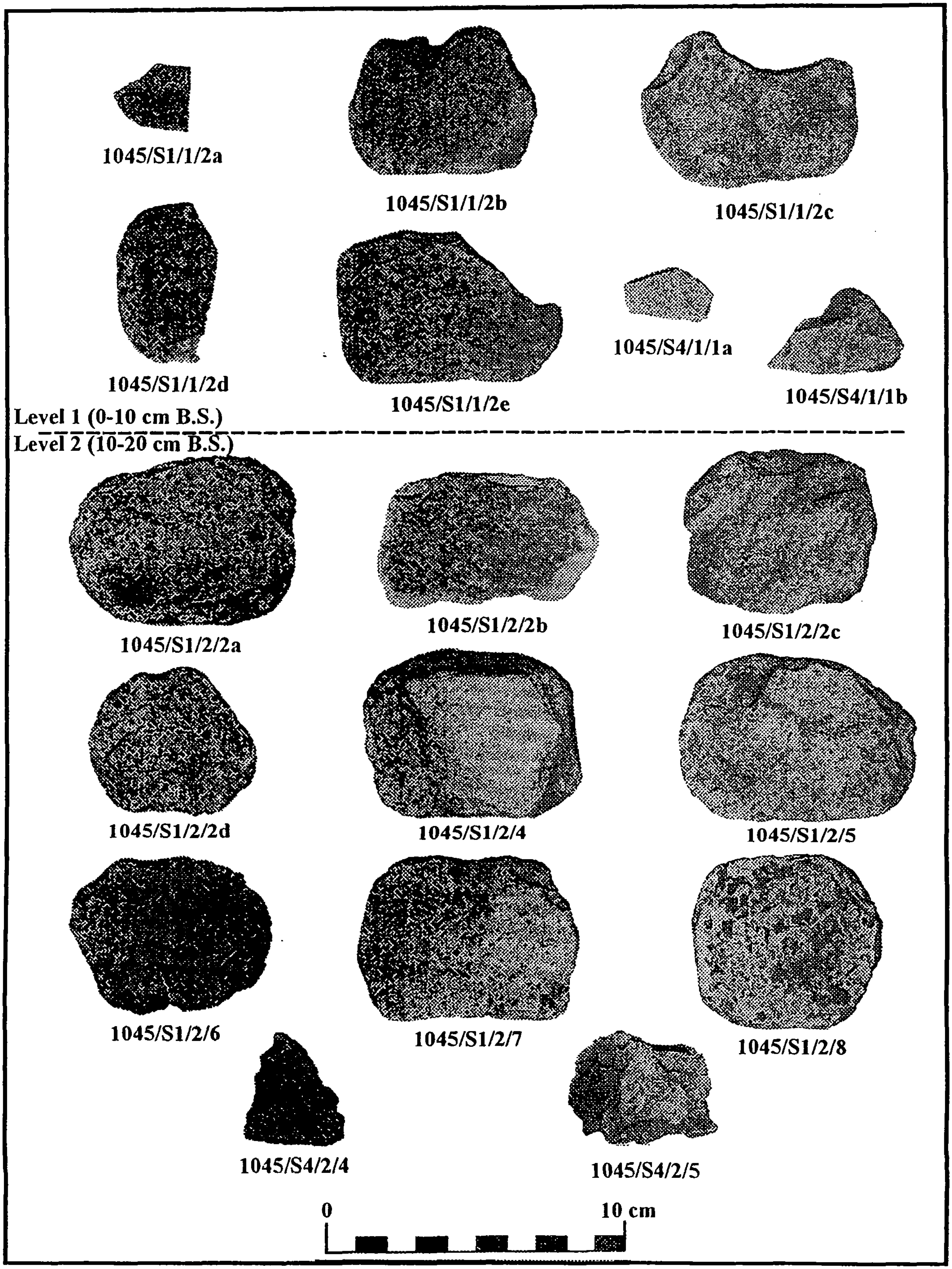


Figure 57: Stone disks recovered in Levels 1 and 2 at 24LN1045.

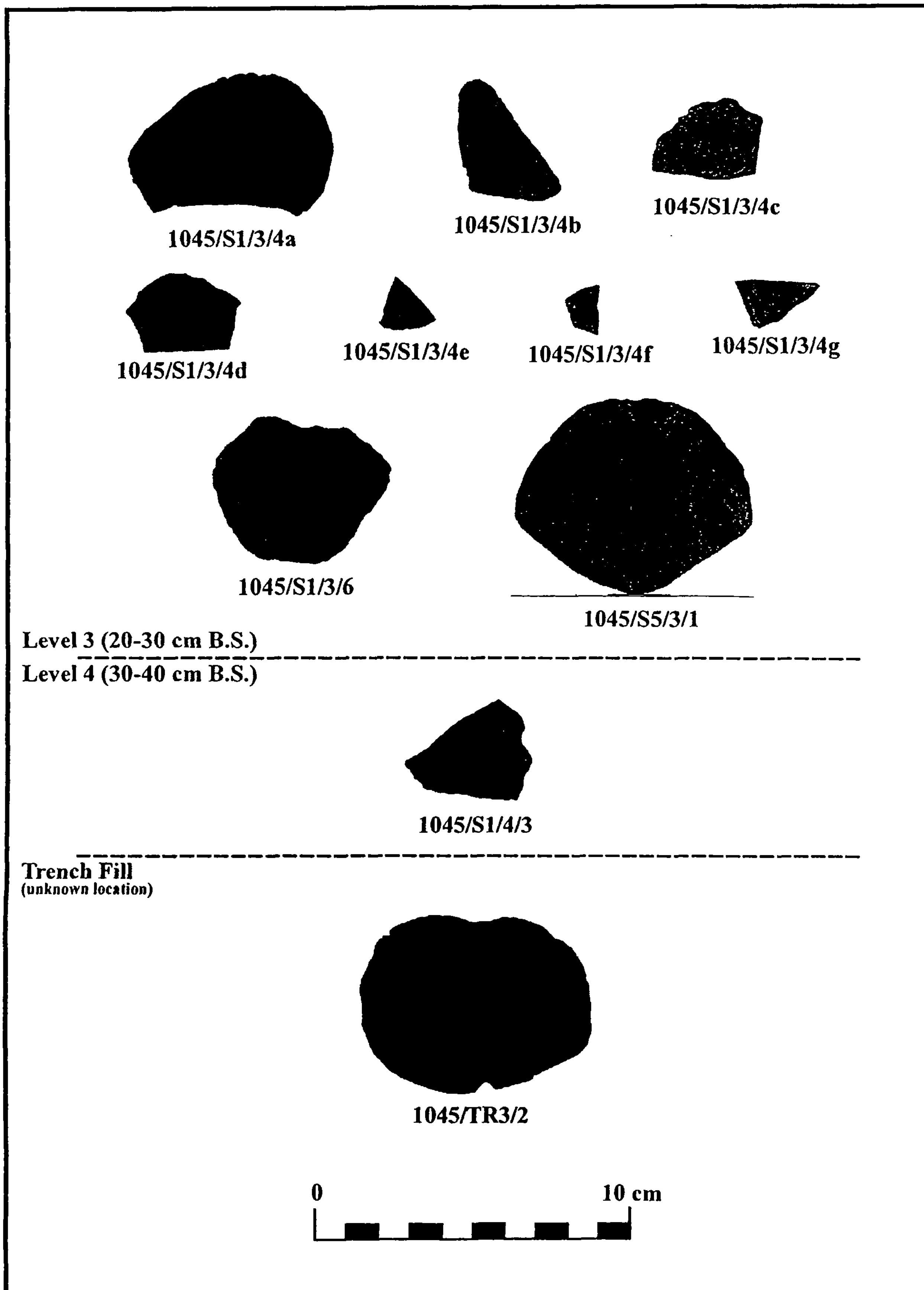
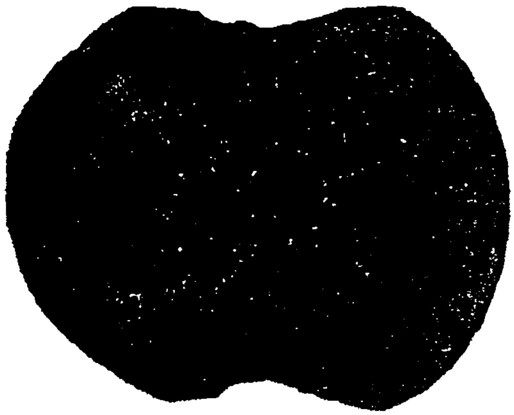
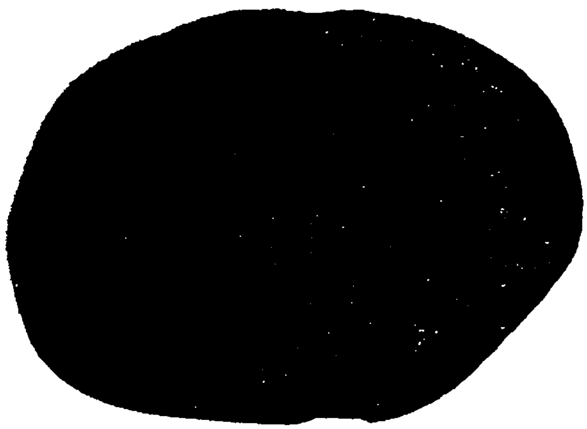


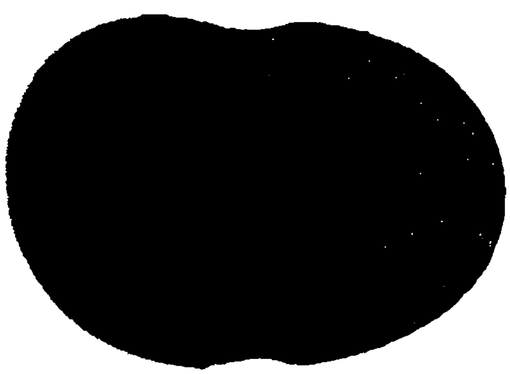
Figure 58: Stone disks recovered in Levels 3 and 4 and Trench 3 at 24LN1045.



(a) 1045/S1/Surface/1



(b) 1045/South/Surface/9



(c) 1045/KDC-2/S/2

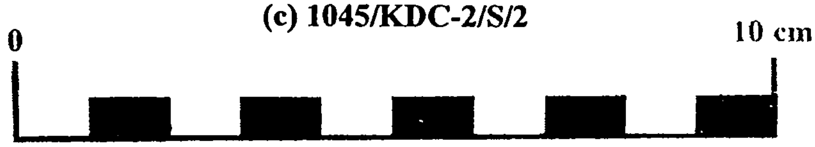


Figure 59: Notched pebbles from 24LN1045.

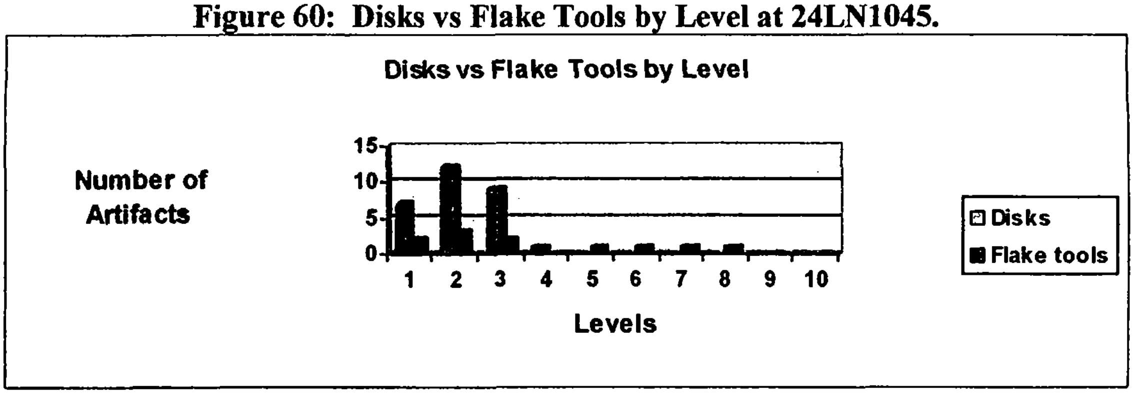
actual notched cobble net sinker (1045/S1/Surface/1)(Figure 59a) recovered from Rainy Creek is a smooth flat river cobble with notches. This notched cobble or pebble measures 6.5 x 5 cm, is 1 cm thick, and weighs 83.5 grams. In contrast, a similarly sized chipped disk measuring 6 x 6 cm, is 0.3 cm thick, and weighs only 24.8 grams.

Chipped disk tools were likely used for cutting and scraping tasks, taking the place of expedient flake tools that are often found at other sites. An early article on the archaeology of the Kootenai Valley described a variety of artifacts found at prehistoric campsites around Libby (Kootenai Times, January 20, 1915), including a probable reference to chipped disk tools. "They (Kutenai Indians) frequently used any piece of shale rock that was handy for this purpose (as scrapers)".

The Rainy Creek site yielded a low frequency of flake tools and unifaces, only 12 and 4 respectively, compared to 16 bifaces, 13 projectile points, and 30 stone disks. At archaeological sites where a variety of tasks associated with butchering and processing of game were being carried out, more flake tools than bifaces and projectile points is sometimes an observed pattern. Flake tools are often described as "tools of the moment" and were produced with little energy investment. Replicative stone tool studies have shown that flake tools are very effective for cutting meat and tendons, as well as for scraping and cutting hides. A likely explanation for the prominence of chipped disk tools over flake tools (Figure 60) in the Rainy Creek assemblage is that the disk knives were the "tools of the moment" or expedient tools for local site occupants.

The raw material for stone disks is far more common locally than any other lithic materials observed at the site. Flaking patterns vary on the disks and include irregularly applied bifacial and unifacial edge flaking, regularly applied bifacial and unifacial edge flaking. Some specimens exhibit almost no flaking at all. Working edges are dominantly steep-angled or obtuse, suggesting that scraping may have been a dominant activity. A few specimens also exhibit acute-angled edges indicating that the disks may also have been used for cutting.

Figure 60: Disks vs Flake Tools by Level at 24LN1045.



Vertical distributions (Figure 60) of flake tools and stone disks shows an obvious pattern of earlier appearance of flake tools and later appearance of disk tools. It is possible that stone disks or disk knives are diagnostic of the late Middle Prehistoric Period, the Late Prehistoric

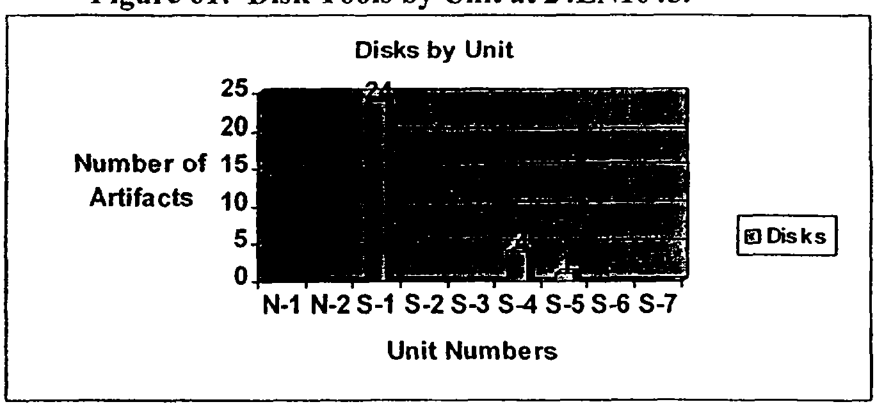
Period, and the Protohistoric Period. Flake tools appear to have remained a popular tool type from earlier periods through later periods.

A striking pattern of horizontal distribution of stone disks is apparent in the Rainy Creek specimens (Figure 61). All but two of the disk specimens were recovered from adjacent units S-1 and S-4. One disk one found in unit S-5 adjacent to the hearth dated to about 320 years ago. Another disk was found out of place in backhoe Trench 3. Interestingly, these two excavation units also had the highest frequency of heat-altered rock and deer-like bone. This co-occurrence is interpreted as an indication that the stone disks were being used to process deer.

Ground Stone and/or Pecked Stone Artifacts and Manuports
*see Table 9: Appendix B for metric and non-metric descriptions

This class of artifacts differs from chipped stone in that they were manufactured by, or show wear from, grinding or pecking. For example, the grooved malls found at many sites throughout Montana are believed to have been produced by both pecking and grinding. These tools were fashioned by first using a small narrow cobble to peck out a rough groove around an ovoid cobble. Sand was then placed in the groove and a rawhide rope or strip was placed over the sand and was moved back and forth to abrade a more finished, smoother groove, much as sand paper of varying grit is used to finish wood today. Some artifacts in the ground and pecked stone category display patterns of wear that were produced as a result of their use. For example, the small narrow cobble used to peck out a groove, as described above, would likely show small pock marks on the end used to create the rough groove. Manos or pestles, so common at sites along the Kootenai River, often show wear or abrasion on at least one end. This wear pattern was created by using the tools to grind seeds, roots, meat, or bone in stone bowls or on stone slabs (mortars or metates).

Figure 61: Disk Tools by Unit at 24LN1045.



Manuports is a term applied to items that often do not show obvious shaping or wear but cannot be attributed to natural occurrence at archaeological sites. For example, unmodified river cobbles are often found along with other archaeological materials in fine-grained sediments of T1 terraces along the Kootenai River. These fine-grained sediments were laid down during episodes of low energy overbank flooding. Floodwaters associated with these fine-grained sediments do not have enough energy to carry large cobbles. Therefore the occurrence of such cobbles in fine-grained sediments cannot be attributed to natural processes. Human transport of the cobbles is thus a more likely explanation for the occurrence of the cobbles even if their uses cannot be ascertained.

A variety of ground stone artifacts and/or manuports were recovered from the Rainy Creek site investigations. Twelve objects from this broad artifact class were recovered from the site (Figures 56b, 59a-c, 62, 63, 64, 65, 66, 67, 68 and 69). They include four mano/pestles, two long cobbles, one tested cobble/chopper, a round golf ball-sized stone, a grooved maul or grooved net weight, and three notched pebbles.

One of the mano/pestles (1045/N/Surface/2) is a long cobble with four planar sides or faces (Figure 62). It is 26 cm long and the faces are 3 to 4cm wide. This artifact is very smooth on all four sides and exhibits obvious abrasion and pecking wear on both ends. The other mano/pestle (1045/South/Surface/11) is nearly identical in shape, measuring 25.5cm long, with the sides/faces measuring 3.5 to 4cm in width (Figure 63). Two opposite sides/faces have been ground very smooth. Although one end of this artifact has been broken off, the other end exhibits minor abrasion and pecking. Immunological analysis of this artifact resulted in a positive antisera reaction for a plant species from the Capparaceae (Caper) family. Both of these manos are made from the same material, a dense, dark grey to black, microcrystalline rock. Interestingly, the Kootenai Times published an interview with John V. Campbell, a white Hudson's Bay employee who came to the Tobacco Plains area in 1866 (Kootenai Times 1914). Campbell recounts his observations of Kutenai Indian tool-making and states that the same kind of rock, "black iron rock that is harder than any other kind of rock", was "always" used as a hammerstone and pestle. He goes on to describe how the long cobbles of "black iron rock" were used to pound out "a round hole" in another softer rock to create mortars for grinding berries. The two Rainy Creek pestles described above fit the Campbell description of Kutenai hammerstone/pestles. There are reports that some magnetite (an iron ore) deposits, are present in the Vermiculite Mountain and Rainy Creek areas as well as in other areas of igneous activity in the Libby area. The Rainy Creek pestles appear to fit the description of magnetite and they are much denser and heavier than the common quartzite and argillite cobbles found in the Kootenai River gravels.

The tested cobble/chopper (1045/S7/1/2) consists of a flat rounded river cobble that is 5.5cm long by 6cm wide (Figure 56b). The cobble has been split and may have been used as a small chopper, although use wear, if present, is very subtle. This tool is presently classified as a manuport.

The round golf ball-sized stone (1045/S7/3/1)(Figure 64) does not exhibit readily apparent use wear or modification, but is considered to be an artifact or manuport because its occurrence at the site is likely the result of human actions. It was found in level 3 of unit S-7 where rounded cobbles do not occur naturally. The stone is approximately 4 cm in diameter and its function is unknown.

One manuport/cobble (DP/KDC-1/South/3) is an ovoid river cobble, measuring 19cm long by 7.5cm wide and 2.5cm thick (Figure 65). This artifact exhibits minor pecking on the

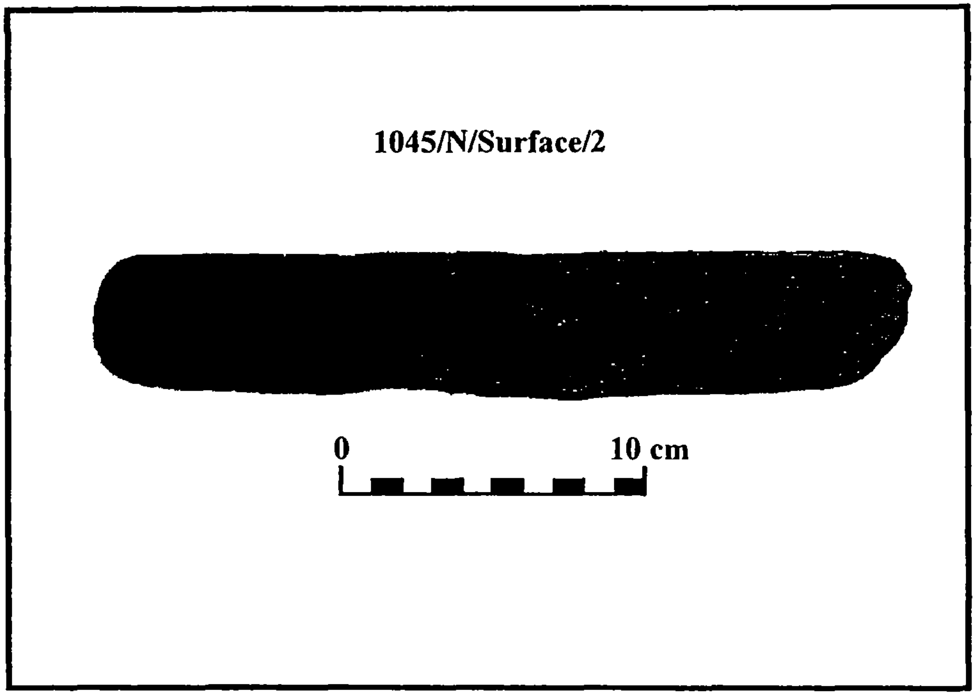


Figure 62: Mano/pestle from 24LN1045.

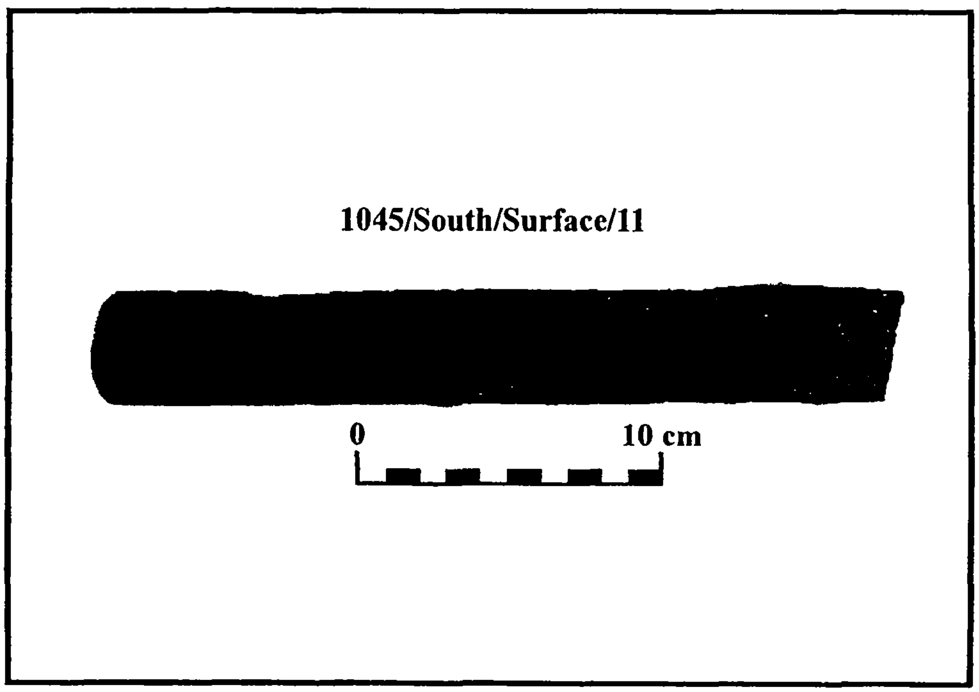


Figure 63: Mano/pestle from 24LN1045.

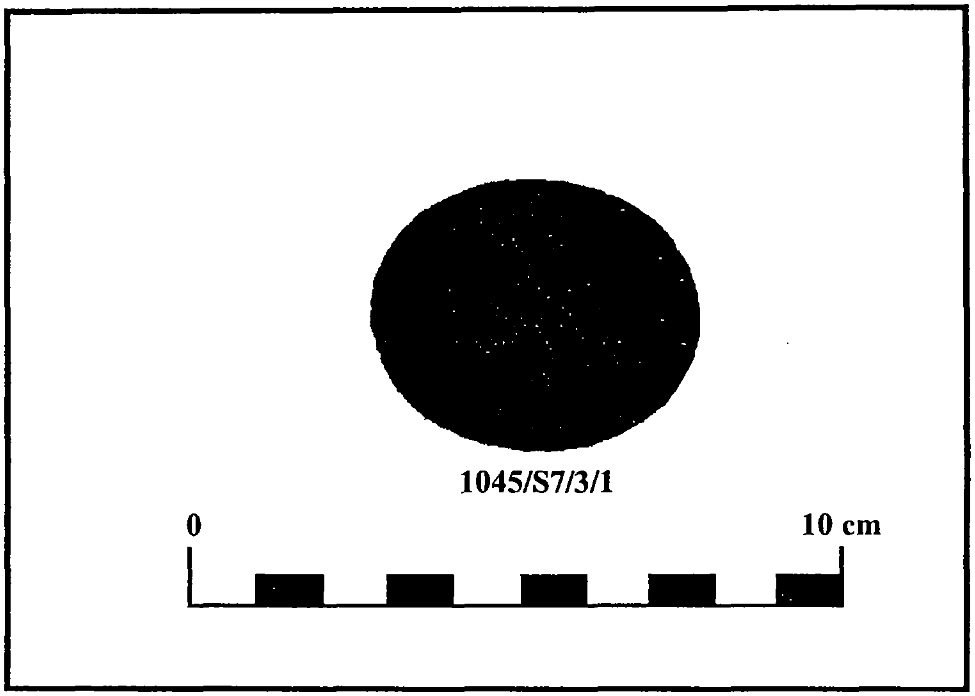


Figure 64: Manuport from 24LN1045.

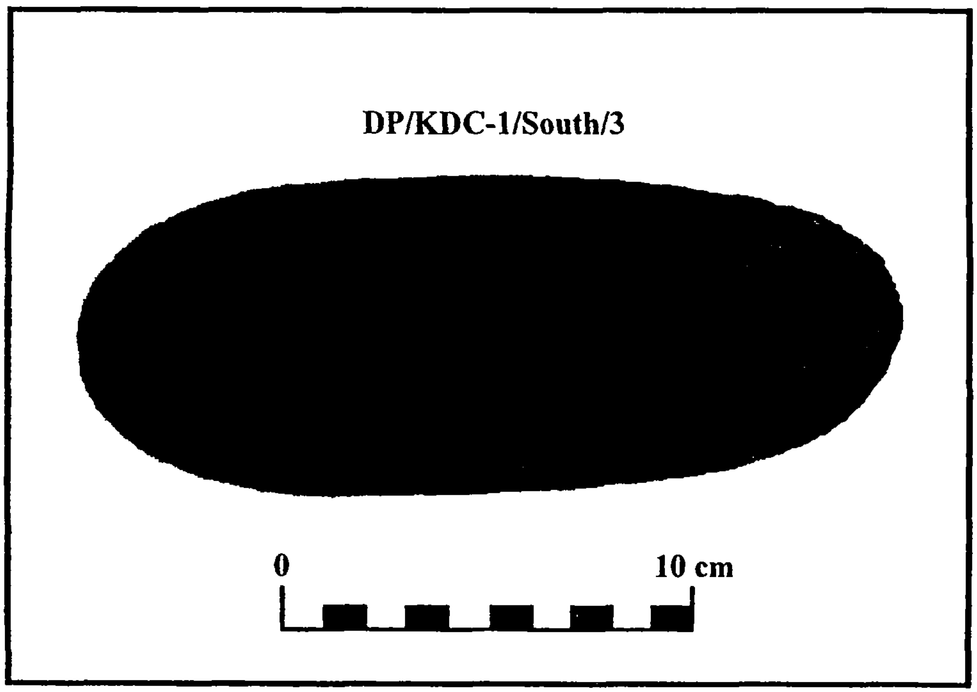


Figure 65: Manuport/cobble from 24LN1045.

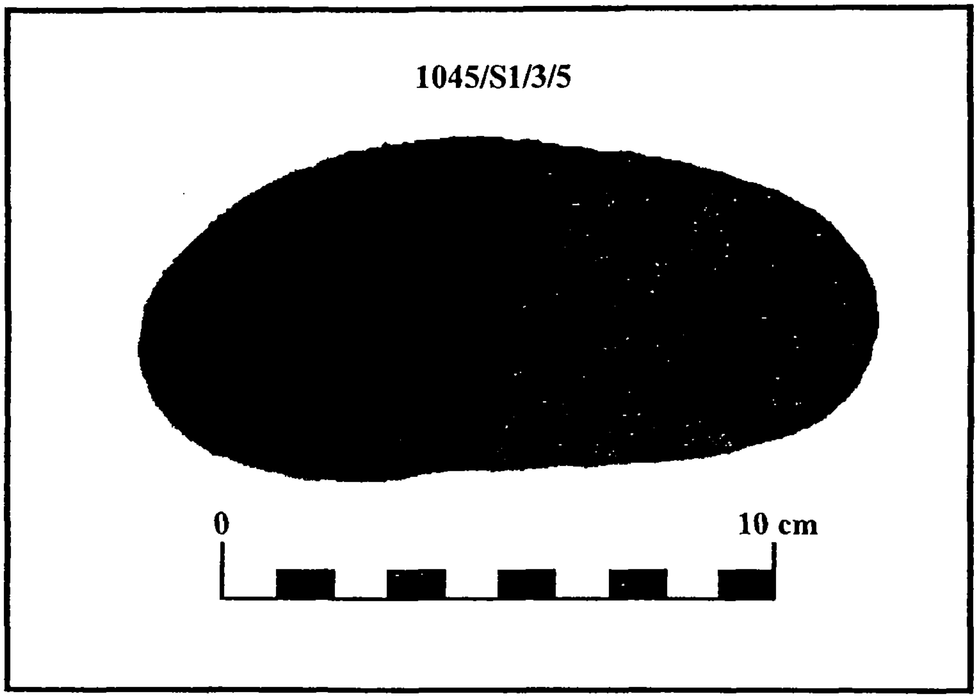


Figure 66: Ground stone cobble from 24LN1045.

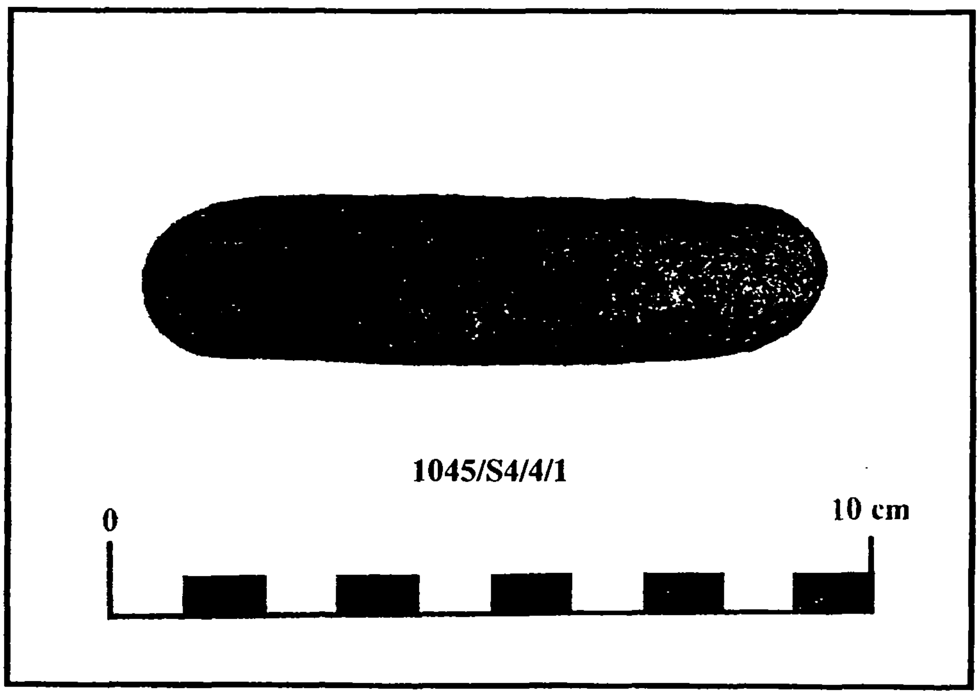


Figure 67: Pecked stone "pestle" from 24LN1045.

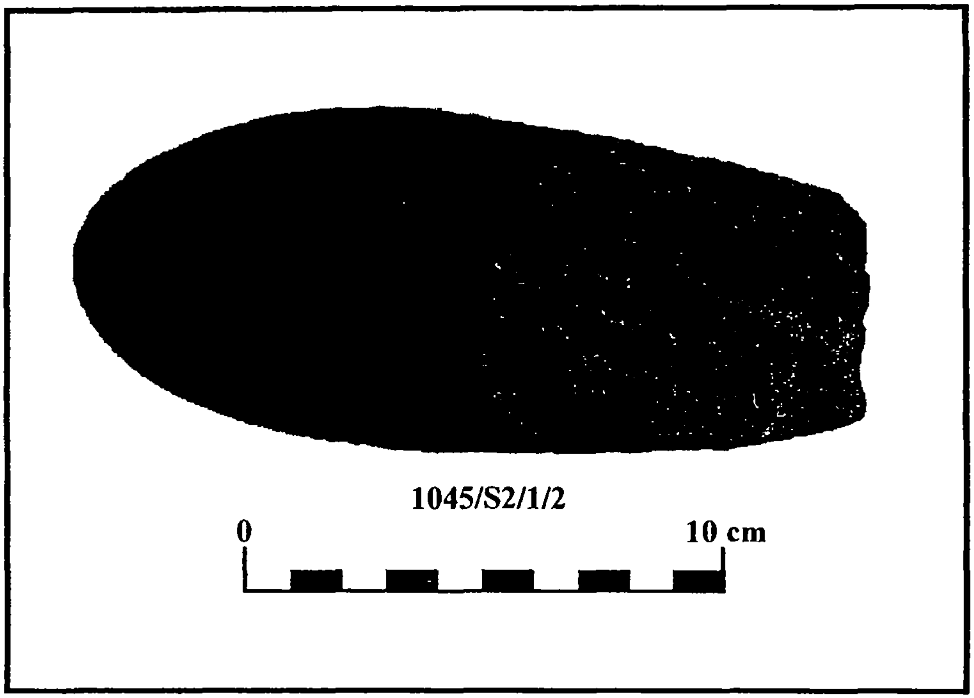


Figure 68: Mano/manuport from 24LN1045.

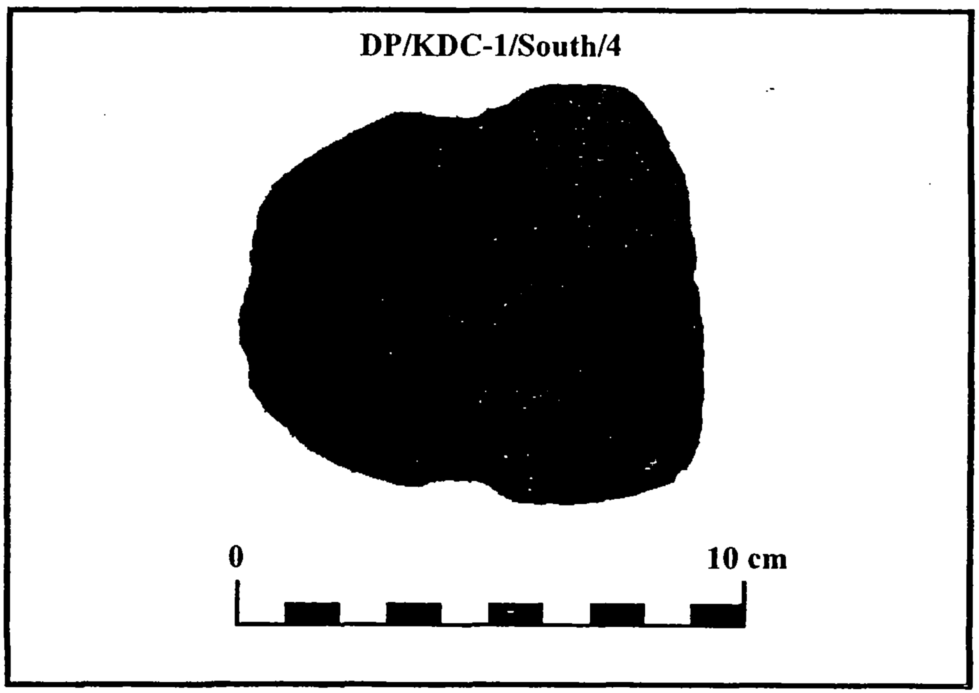


Figure 69: Grooved maul from 24LN1045.

lateral edges, as well as some abrasions on the flat surfaces. It is not clear if the abrasions and pecking are cultural or natural. However, the cobble was found in the deep culture-bearing paleosol in backhoe Trench KDC-1 where all other rock was either heat-fractured or sub-angular natural rock. This cobble is likely a manuport that was used as a mano/pestle. Immunological analysis of this artifact produced negative antisera results.

One modified cobble (1045/S1/3/5) is a 12cm long river cobble that is naturally rounded on one side (Figure 66). It is also roughly wedge-shaped or triangular in cross-section, as two sides appear ground to form a crest along the ventral edge. This working edge has apparently been heavily battered, though the exact function or use-wear pattern is unclear (either grinding and/or pounding). The artifact was recovered from Level 3 (30cmbs) from Unit S-1.

A very small "pestle" or long river pebble with use-wear (pecking) on one end (1045/S4/4/1) was recovered from Level 4 (40cmbs) of Unit S-4. This unit exhibited the highest frequencies of both bone and debitage. The pebble artifact measures 9cm long by 2cm wide on one face and 1.5cm wide on another face (Figure 67). The tool is unmodified except for use-wear on one end. The tool is suitable for use in flintknapping activities, an assumption made by field crew when the item was discovered during site excavation. Surprisingly, immunological analysis of the small stone tool returned positive antisera reactions for a plant species from the Chenopodiacea family and a positive reaction for rabbit.

One manuport/mano (1045/S2/1/2) consists of a cobble measuring 15cm by 6cm by 4cm (Figure 68). The cobble is unmodified except for possible minor use wear on one end. This stone was recovered in the top 10cm of Unit S-2.

A grooved maul (DP-KDC-1/South/4) was recovered from Trench KDC-1. The maul was not found in place but lay on a backhoe-exposed ledge defining the top of a deep, culture-bearing paleosol approximately 124-150cm below surface. The artifact consists of a river cobble with a pecked, circumlinear groove (Figure 69). This fully-grooved cobble has one "dimple" or small concavity, either pecked into both ends of the stone, or created through use as a hammer stone. Similar stones found in western Montana have sometimes been classified as mauls and as net weights (Thoms 1984; McLeod and Melton 1986). The stone weighs 600 grams. Immunological analysis of the stone was negative. The deep paleosol from which this artifact was recovered was dated to approximately 3720 BP. This early date argues against the tool's use as a net sinker, as use of net sinkers is not believed to have begun until the Kavalla Phase (1000 B.C.-A.D. 200). The tool could have been used as a hammer for cracking animal bone for marrow extraction or bone grease production.

Three notched pebble or cobble net sinkers were recovered from the Rainy Creek site (Figure 59a-c). One is a flat, smooth, water-worn cobble measuring 4cm wide by 6cm long by 1.2 cm thick and weighing 64.2 grams (1045/KDC-2/S/2). It is notched on both edges (Figure 59c). The notches appear to have been created by pecking or crude flaking. This net sinker was found in trench fill on the south end of the site. Another notched pebble is of similar stone (1045/S1/Surface/1) and is 6.5cm long, by 5cm wide, by 1cm thick, and weighs 83.5 grams (Figure 59a). This notched pebble was found on the surface, approximately 10m south of Unit S-1. The third net sinker (1045/South/Surface/9)(Figure 59b) is a notched pebble found on the surface of the south side of the Rainy Creek site. The only other evidence of fishing found at the site is one possible fish bone that was recovered from the first 10cm of Unit S-4, not far from where these notched pebbles were found.

Bone Tools

A single bone tool was recovered from 24LN1045 during the 2000 excavations. This artifact is a bone awl fashioned from what appears to be a long bone fragment of a medium-size ungulate (deer size). The tool has been sharpened to a fine tip and is highly polished (Figure 70). The awl came from one of the deepest culture-bearing levels (level 7: 60-70cm below surface) in unit S-1. The awl is 7.18cm long and is 0.91cm wide at the base. The distal portion of the tool exhibits some fine striations. The striations and polish are likely a result of soft-tissue use wear suggesting that the tool was used for perforating hide.

Features and Heat-altered Rock

Only one feature, perceived as intact, was exposed during hand excavation of units at 24LN1045. A portion of another feature was exposed in the north wall of backhoe Trench 3. One of the problems associated with identifying features was the small excavation sample. Simply not enough contiguous space was opened through hand excavation to determine if some of the dense concentrations of heat-altered rock (HAR) that were routinely encountered were discrete features or were just part of a dense "midden" of heat-altered rock, butchered bone, and scattered bits of charcoal. Indeed some of the features exposed during the LAURD project were much larger than the one meter square units excavated during 2000 investigations at Rainy Creek (Roll and Smith 1982). The absence of concentrated charcoal and discrete areas of oxidation may be an indication that concentrations of heat-altered rock, so common across much of the Rainy Creek Site, were not associated with discrete features. However, the dense "pavement" of heat-altered rock, often associated with butchered, fragmentary bone, may in itself be characterized as a site-wide feature indicative of certain activities and processes that were being carried out by occupants of the site.

Heat-altered rock along with bone fragments were by far the most abundant cultural material recovered during excavations. A total of 2722 pieces of heat-altered rock were noted in the excavation units. In general heat-altered rock and bone were more concentrated in units proximal to the edge of the Kootenai River on the south side of Rainy Creek (Figure 5). Units S-1 and S-4 yielded 1301 pieces of HAR and unit S-7 yielded 620 pieces. Units S-2 and S-3 were the lowest yielding on the south side of Rainy Creek with S-3, farthest from the river of any units, producing only 17 pieces of HAR. The two units (N-1 and N-2) placed on the north side of Rainy Creek, although adjacent to the Kootenai River, yielded only 87 pieces of HAR. This data together with observations of the river bank, backhoe cut, and heavy equipment stripped areas suggests that HAR frequency on the north side of Rainy Creek was far less than that of the south side of Rainy Creek.

Heat-altered rock was virtually continuous through the upper 40cm of sediments on both the alluvial fan and the T1 terrace. However there were distinct differences in per level yields of HAR (Figure 71). Levels 2 and 3 produced 1902 pieces of HAR or just under 70% of all HAR

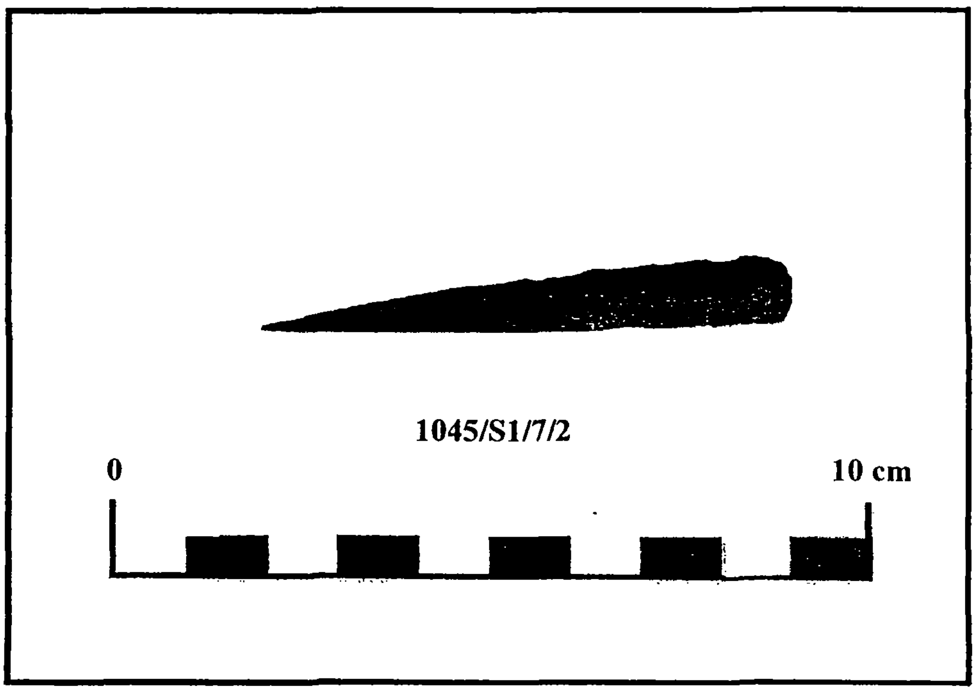


Figure 70: Bone awl from 24LN1045.

recovered during excavations. Frequency of heat-altered rock and all cultural materials decreased with depth in the one meter of sediment excavated in all units. Just 183 pieces (6.7% of the total) of HAR were found below Level 4 and the majority of these were found in Level 5. No HAR was found in levels 9 and 10 in any of the units.

It is not known if the unsampled, more deeply buried, cultural occupations associated with two paleosols exhibit the same pattern of densely occurring heat-altered rock. The small examined sample of the deep culture-bearing paleosol found in backhoe Trench KDC-1 suggests that heat-altered rock is common in that ca. 3720 BP occupation.

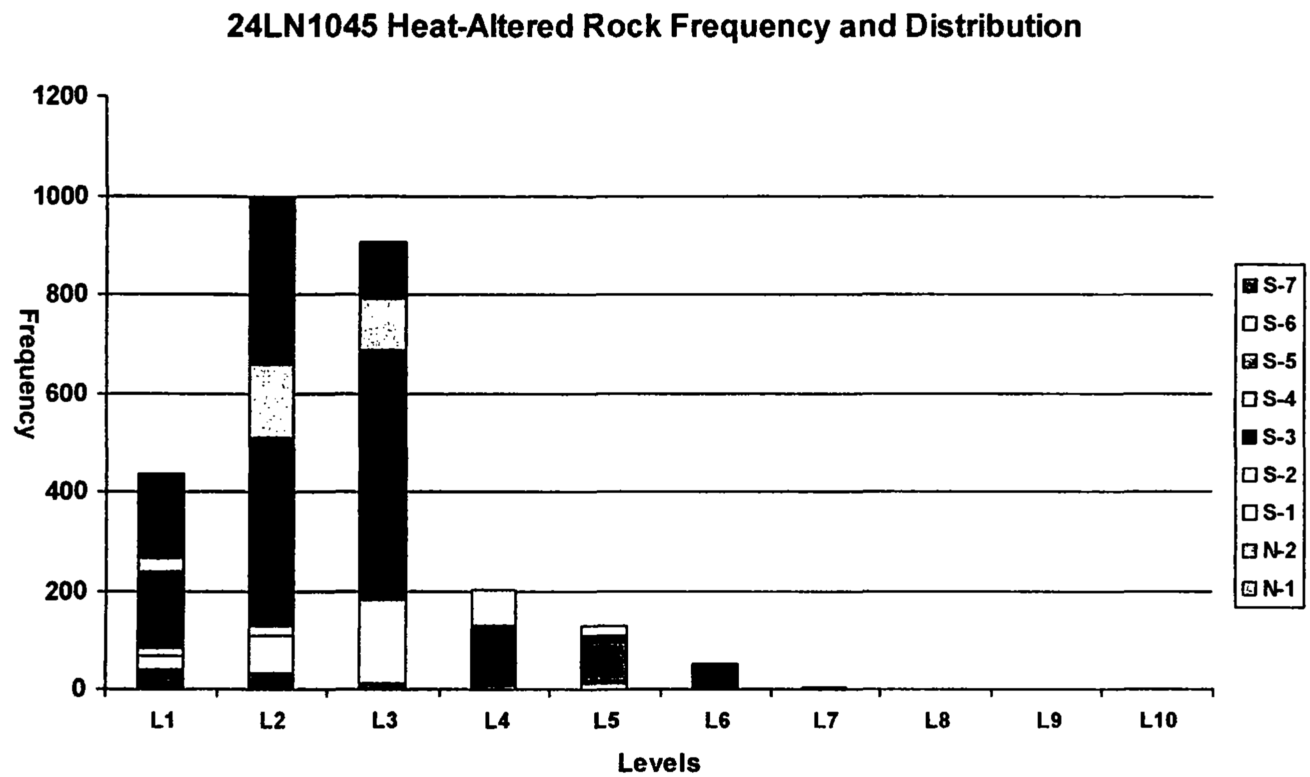


Figure 71: Heat-Altered Rock Frequency and Distribution at 24LN1045.

Roll and Smith (1982) interpret the absence of charcoal and oxidation of heat-altered rock concentrations at some sites, and in some areas of some sites, as an indication that stone-boiling of meat and bone occurred. In other areas, they identified more discrete features with associated charcoal and oxidation and interpreted these features as baking pits and cooking hearths. Although unburned bone dominated the faunal assemblage at 24LN1045, burned and calcined bone were also present. This fact, together with the presence of discrete features and more generally dispersed heat-altered rock, suggests that both stone-boiling and roasting or baking occurred at the Rainy Creek Site. The extreme fragmentary nature of a majority of bone found at the site may be an indication that bone grease production through boiling may have been a major activity. Form or morphology of HAR recovered from the site varied with highly fractured, crazed, and kernelized fragments noted along with less fractured pieces. Some complete, unfractured rocks that were heat oxidized were also noted. These observations also suggest that a variety of heating techniques were used by site occupants, including stone boiling, stone platform roasting, and open air surface roasting.

Feature 1 (Unit S-5: T1 Terrace)

This feature was partially exposed during excavations and occupied all but the east and south edges of the unit (Figures 38 and 39). It was defined by 76 pieces of heat-altered rock, the bases of which lay at average depths of 17 to 19 cm below surface. The heat-altered rock overlay an area of small, degraded bits of charcoal and organic sediment that averaged 2 to 4cm thick. A small pocket of this matrix, near the center of the heat-altered rock cluster dipped to about 24cm below surface. It does not appear that a formally prepared basin was constructed below the rocks. It appears more likely that this feature was a hearth that was constructed on the site surface. Presence of the charcoal and oxidation beneath the stones may indicate that a bed of charcoal was first prepared and rocks were placed within and over the top of the charcoal. This feature is interpreted as a roasting platform. Both burned and unburned bone was found within, and adjacent to the feature. All of the feature matrix was collected during excavation and was submitted for radiocarbon dating. A date of ca. 320±60 (Beta – 154450) was obtained from the hearth matrix, which suggests a protohistoric association with the Kootenai/K'tunaxa.

Feature 1 (Backhoe Trench 3: Alluvial Fan)

This feature was exposed in the north wall of Trench 3 during backhoe excavation (Figure 14). The feature had a shallow basin shape and extended from 39 to 50cm below surface. The basin was infilled with degraded charcoal and organic sediment. As with Feature 1 in unit S-5, the basin was overlain with heat-altered rock. Seventeen (n=17) pieces of heat-altered rock were noted on the surface of the basin and on both edges of the basin. Very slight oxidation was noted at the base of the basin. The basin portion of the feature was about 32cm wide at the top whereas the width defined by associated heat-altered rock at the top of the basin was about 84cm. As in the case of the unit S-5 feature described above, the feature in Trench 3 is interpreted as a roasting platform where a bed of coals was first prepared and then overlain with rock. Both burned and unburned bone were noted in association with this feature and several chert flakes were noted adjacent to the feature. The matrix of the shallow basin was collected and all of it was submitted for radiocarbon dating. A date of ca. 1810±50 BP (Beta – 154451) was obtained from the matrix sample, suggesting an association with Roll's Kavalla or Stonehill Phases or Reeves' Pelican Lake Phase/Blue Slate Canyon Subphase (Roll 1982; Reeves 2000).

Faunal Assemblage

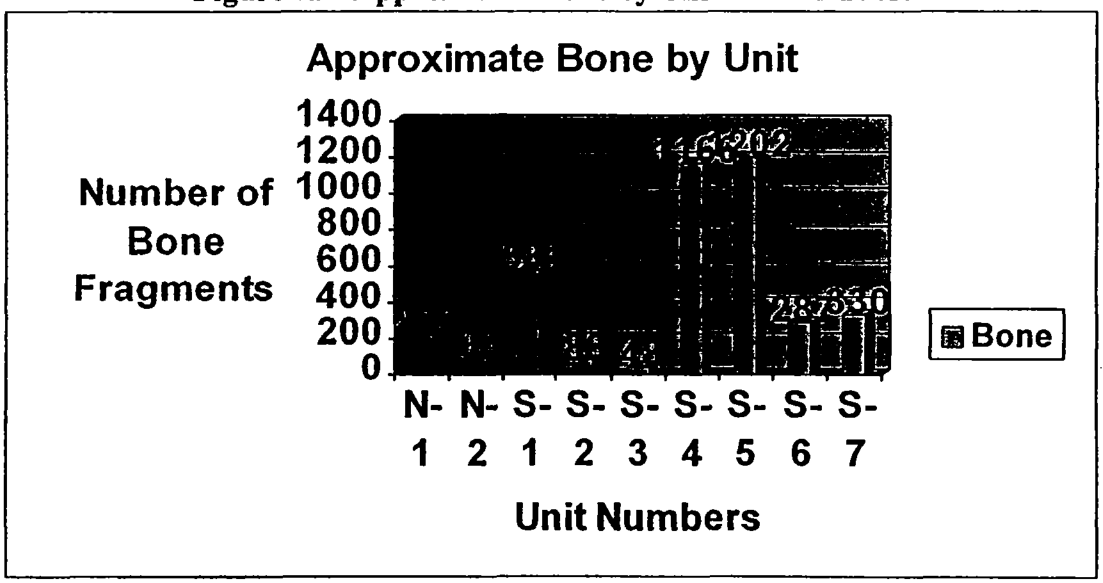
As mentioned earlier in this report, all bone material recovered during the 2000 excavations at 24LN1045 were submitted to a faunal specialist from Lincoln, Nebraska in February of 2001. This specialist was subcontracted to carry out detailed technical analysis of the bone. The faunal specialist failed to complete a report in the specified time. He also failed to return the bone after repeated telephone calls and e-mails requesting that he do so. A basic catalog of the bone from 24LN1045 was prepared prior to sending the entire assemblage to Lincoln. Some basic faunal observations were made by ACRCS in the field and in the laboratory but these by no means suffice as adequate faunal analysis. Those general observations and some basic distributional graphs are presented below.

The overwhelming majority of bone from the site was fragmentary pieces of what appears to be a medium-size ungulate. Burned and calcined bone was represented in the fragments but the majority appeared to be unburned. Some mandibles and mandible fragments were also recovered and were tentatively identified by ACRCS as associating with a species of *Odocoileus* (deer). Several skull fragments, including two with antler buttons, were noted and were tentatively identified as whitetail deer (*Odocoileus virginianus*). Several long bone fragments with articular ends were among recovered bone and they also associate with a medium (deer-like) ungulate.

One bone tentatively identified as associating with fish was observed and another bone was thought to be from a small mammal.

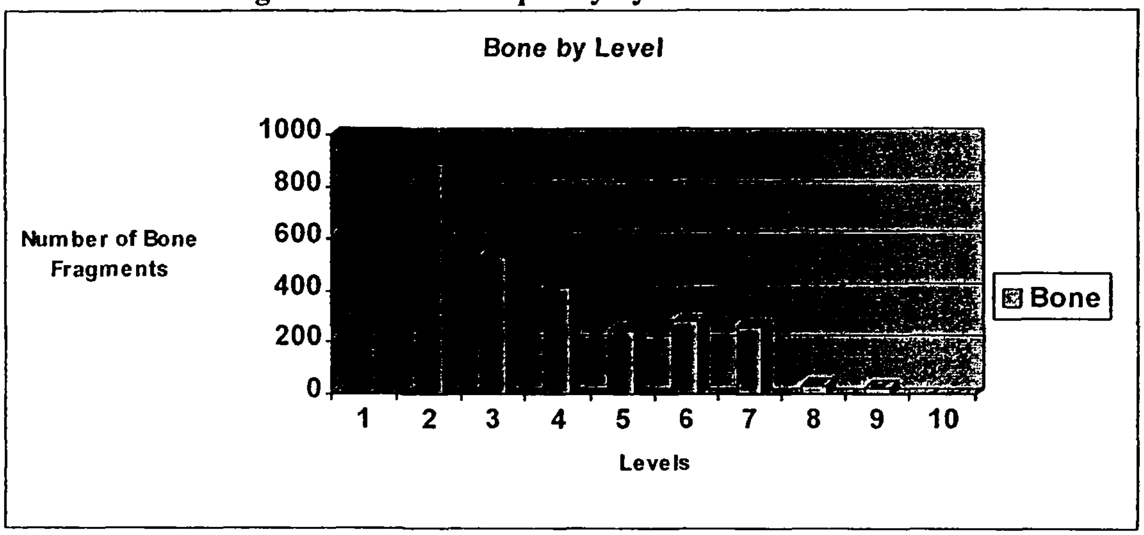
Preliminary counts of recovered bone shows distributional patterns that nearly mirror that of heat-altered rock (HAR). Figure 72 shows that units S-4, S-5, and S-1 yielded the most bone with fair quantities in S-7. Units S-4, S-5, and S-7 also yielded the most heat-altered rock with S-1 containing nearly the same amount of HAR as S-5 (see Figure 71). There is a very strong correlation between frequency of bone and frequency of HAR.

Figure 72: Approximate Bone by Unit at 24LN1045.



Vertical distributional patterns of bone are very similar to distributional patterns of lithic debitage (Figure 73). There is a steady increase in bone occurrence from the lower levels to the peak bone frequency in level 2. There is an abrupt jump in frequency from level 8 to level 7 and there is an abrupt drop in bone frequency from level 2 to level 1. As with other cultural materials, these bone frequencies indicate increasing use of the site from the middle Middle Prehistoric Period through late Middle Prehistoric times on into the Late Prehistoric Period. Site occupancy, based on gross vertical distribution of bone and other cultural materials, appears to drop off abruptly during the latest Late Prehistoric Period and Protohistoric times. Of course without good stratigraphic separation it is not possible to strongly assert this chronology of occupation. It is possible that cultural materials found in level 1 could associate with materials in level 2. It should be noted however, that cultural materials were found to occur on or very near the surface in all the units.

Figure 73: Bone Frequency by Level at 24LN1045.



Historic and Protohistoric Artifacts

Glass Trade Bead

One glass trade bead (1045/S5/1/1: Figure 74) was recovered from level 1 in unit S-5 on the T1 terrace. This opaque glass artifact is a wound bead that is light blue in color. Wound beads are made by wrapping hot glass around a non-glass (commonly iron) mandrel. The bead has a simple structure, composed of one layer and exhibiting no ornamentation or internal decoration. The bead is oblate spheroid in shape and is circular in cross section. The bead is 5mm (3/16 inch) in diameter.

Blue beads are the most common found at archaeological sites in Montana. They are known through the ethnographic and historical record to have been preferred by many Indian groups in the West. The Lewis and Clark expedition found that blue and white beads were valued, but beads of other colors were often refused:

> [T]he object of foreign trade which is the most desired, are the common cheap, blue or white beads, of about fifty or seventy to the penny weight, which are strung on strands a fathom in length, and sold by the yard, or the length of both arms; of these [,] blue beads, which are called tia commachuck, or chief beads, hold the first rank in their ideas of relative value; the most inferior kind are

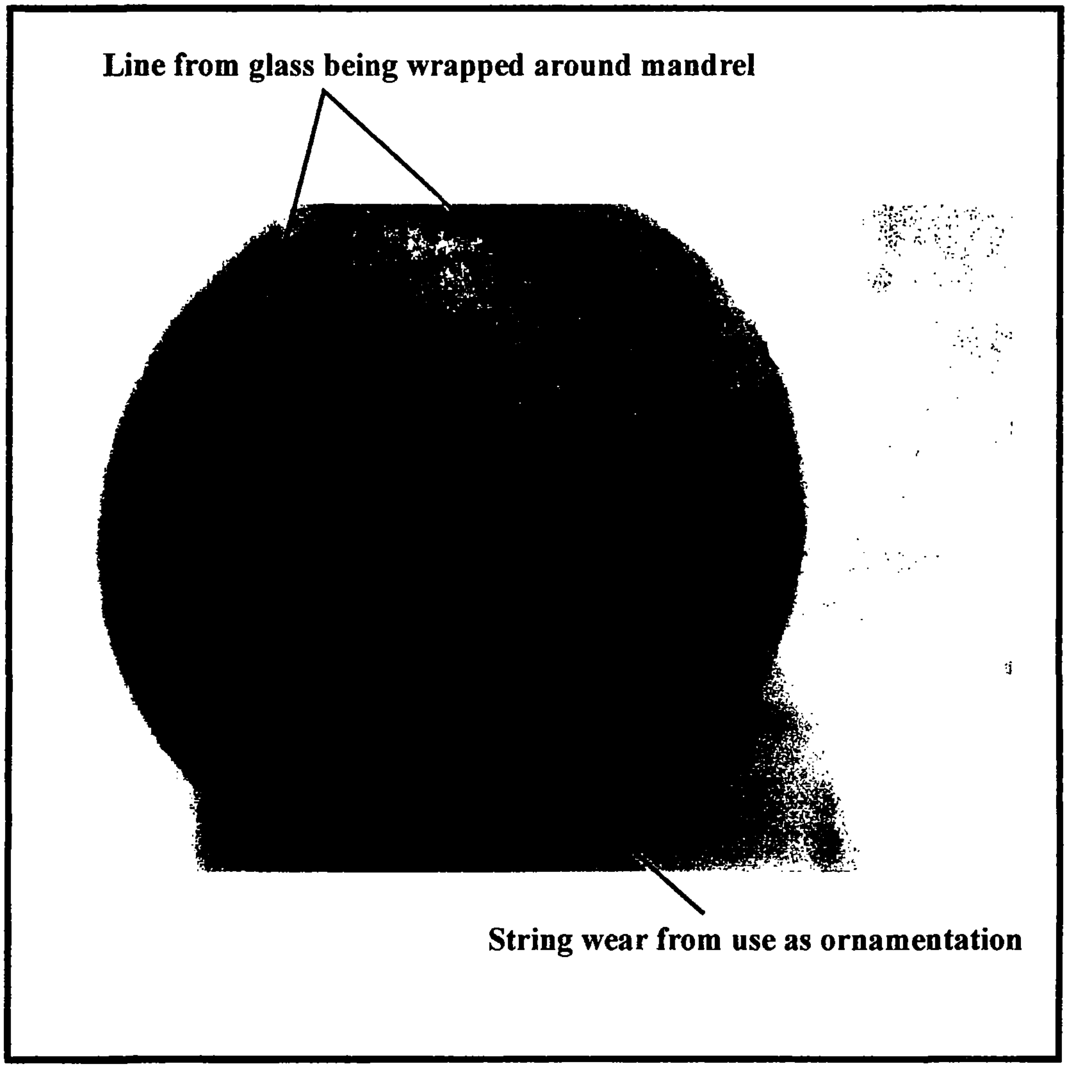


Figure 74: Glass trade bead from 24LN1045.

esteemed beyond the finest wampum, and are temptations which can always seduce them to part with their most valuable effects. Indeed, if the example of civilized life did not completely vindicate their choice, we might wonder at their infatuated attachment to a bauble in itself so worthless. Yet these beads are, perhaps, quite as reasonable objects of research as the precious metals, since they are at once beautiful ornaments for the person, and the great calculating medium of trade with all the nations on the Columbia (Lewis 1814:114).

The beads that Indian groups in the Northwest possessed when Lewis and Clark entered the area were similar to those referred to as "Padre beads" in the American Southwest (Francis 1986). Padre beads are wound, opaque, light blue glass beads that were manufactured in China from the 17th to 19th centuries. These beads came in three sizes: jumbo (Dogons) 5/8's to 3/4 inch in diameter, mid-sized (Crow beads) 3/8's inch in diameter, and small seed beads 3/16's inch diameter. The bead from Rainy Creek falls into this last size category. Through Spanish and Russian traders, Padre beads spread rapidly into the Southwest and Northwest. These beads came into the Northwest via Alaska, first introduced by Vitus Bering and the Russians who explored that area beginning in 1741. In 1778, English explorer Captain James Cook, surprised to see these beads where Russians had never been, made several references to the effect that it was difficult to obtain supplies and furs from the Pacific Coast Indians without this particular blue bead (ibid).

At least two other similar beads have been found in the Middle Kootenai River Valley, one from site 24LN423, and one from Kootenai Flats. These beads are identified as "Canton wound, late 1700s-1860s" (Thoms 1984:570). The Rainy Creek specimen was found in the first 10cm below surface in unit S-5, just above a hearth date to about 320 years ago. This date and dates of production for Canton/Chinese beads suggests that protohistoric and historic K'tunaxa/Kutenai Indians occupied the Rainy Creek Site at times.

Homestead Era Artifacts

Historic artifacts found at Rainy Creek include a wire nail and a four-hole bone button. The nail was found on the surface of the south side of the site and the button was recovered from Unit S-6, also on the south side of Rainy Creek. In the 1890s, Benjamin (Ben) M. Thomas built a home in the area at the mouth of Rainy Creek. An 1899 GLO map shows the Thomas cabin on the south side of Rainy Creek in an area that is now encompassed by the boundaries of the Rainy Creek site (Bickel 1898). Archaeological investigations in 2000, however, found no evidence of the Thomas cabin. A few bottle fragments and a milk glass jar were found during stripping and removal of asbestos contaminated sediments in a wash north of the former location of the Thomas cabin. These materials appear to date to the period when Thomas lived in the Rainy Creek area, circa 1900.

Immunological Analysis of Artifacts

Fifteen (n=15) lithic artifacts from 24LN1045 were submitted to Bioarch, Incorporated of Cochrane, Alberta, Canada for cross-over electrophoresis (CIEP) analysis. This immunological method was used in attempts to identify plant and animal residues that may have adhered to chipped stone and ground stone tools used by site occupants for processing floral and faunal resources (Newman-Bioarch 2001). The basic process involves comparing antigens (unknown potential animal and plant protein residues in this case) to known antibodies or antiserums. A positive reaction between the antigen and the antiserum produces an identifiable lattice that forms as a result of cross-linking between an antigen related to the antiserum (Newman-Bioarch 2001). Animal antisera used in analysis of the Rainy Creek artifacts included bear, bovine, cat, chicken, deer, dog, guinea-pig, rabbit, rat, sheep, trout, elk, and pronghorn (Table 2).

Table 2: Antisera and related species.

ANTISERA	POSSIBLE SPECIES REPRESENTED BY ANTISERA
Bear	Black, Grizzly
Bovine	Bison, Cow
Cat	Bobcat, Lynx, Mountain Lion, domestic cat
Chicken	Chicken, Turkey, Quail, Grouse, Pheasant
Deer	Deer (all species), Elk, Moose, Caribou
Dog	Coyote, Wolf, Fox, domestic dog
Guinea-Pig	Porcupine, Squirrel, Beaver, Guinea-Pig
Rabbit	Rabbit (all species), Hare (all species), Pika
Rat	Rat (all species), Mouse (all species)
Sheep	Sheep, Goat
Trout	Trout (all species of Salmonid)
Elk	Elk (all species)
Pronghorn	North American Pronghorn Antelope
Agave	Agave
Amaranthaceae	Pigweed
Camas	Camas (all species)
Chenopodiaceae	Chenopodium, Greasewood, Winterfat, Povertyweed
Compositae	Sagebrush, Sunflower, Balsamroot, and many others
Gramineae	Various grasses
Malvaceae	Mallow, Globemallow, Sida, Checker-mallow
Pinon	Pinyon Pine

Utilized plant antisera include agave, Amaranthaceae (amaranth family), camas, Capparadacea (caper family), Chenopodiaceae (chenopod family), Compositeae/Asteraceae (aster/sunflower family), Gramineae/Poaceae (grass family), Malvaceae (mallow family), and pinon/pinyon pine. These antisera "recognize epitopes shared by closely related species and will often identify other species within the individual family" (Newman-Biorarch 2001). Potential related species identified by antisera species used in the analysis of the Rainy Creek artifacts are listed above (Table 2).

All 15 artifacts were submitted for immunological analysis of potential animal residues only while 10 of these artifacts were submitted to analysis for both animal and plant residues. Seven (n=7) of these artifacts tested positive for plant and animal residues (Table 3). Four (n=4) of the artifacts tested positive for animal residue, one (n=1) artifact tested positive for both plant and animal residues, and two (n=2) tested positive for just plant residue.

Results of residue analysis are interesting. Residues from three animals, deer, rabbit, and bovine, were identified. Deer residue would be expected considering that the majority of bone found at the site was from a medium ungulate, most likely deer. Some antler fragments and antler buttons associated with whitetail deer (*Odocoileus viginianus*) were recovered during excavation. Considering the amount of what is most likely deer bone at the site, it is somewhat surprising that only one tool (projectile point base) tested positive for deer. Deer and "deer-like" bone were the most common faunal remains recovered from sites excavated along the Kootenai River during the LAURD project (Roll and Smith 1982). Deer were an important staple among protohistoric and historic K'tunaxa groups and deer marrow was sometimes mixed with pulverized meat (Ray 1942 in Smith 1984; Turney-High 1941). Marrow, as an important dietary element, might explain the fragmentary nature of most of the bone recovered from 24LN1045.

Table 3: Results of Immunological Analysis

Artifact Catalog #	Artifact Description	Immunological Species ID
1045/N1/2/1	Warex/Avonlea projectile point base	Bovine, Rabbit
1045/N1/2/2	Biface (knife or projectile point blade)	Deer
1045/S1/1/1	Drill	Negative
1045/S1/2/2a	Stone Disk (disk knife/argillite knife)	Negative
1045/S1/2/5	Stone Disk (disk knife/argillite knife)	Negative
1045/S1/3/1	Retouched/Modified Flake	Negative
1045/S1/3/2	Uniface/Knife	Capparaceae
1045/S1/4/2	Projectile Point (anomalous type-stemmed, double notched)	Rabbit
1045/S4/2/3	Triangular unnotched point or biface/knife	Rabbit
1045/S4/4/1	Small thin cobble – mano/grinding stone	Rabbit, Chenopod
1045/S6/3/1	Harder/Columbia Valley projectile point – basally corner-notched with short, narrow stem	Negative
1045/South/Surface/6; stripped area	Mano/Pestle – large, long cobble	Capparaceae
1045/TR3/1	Uniface - End Scraper	Negative
DP/KDC-1/South/3	Unmodified long cobble - ?mano?	Negative
DP/KDC-1/South/4	Grooved Mall or Grooved Net Weight	Negative

Three tools tested positive for rabbit. Although rabbit bone was not conclusively identified among site faunal remains, the results are not surprising considering that cottontail rabbits (*Sylvilagus nutallii*) were numerous and frequently observed within the site boundaries during 2000 excavations. The site environment is, and likely was, very good cottontail habitat. Although infrequent, bone from the Leporidae family (rabbits and hares) was recovered from three sites investigated during the LAURD project (Henry 1982). While the presence of rabbit residues on two cutting and/or perforating or penetrating tools (projectile point and knife) is not surprising it seems unusual for such residue to be identified on what appears to be a grinding tool. This tool is a small, narrow cobble that shows use wear on one end and was initially thought to be a knapping stone. However, presence of the rabbit residue along with plant residue on the tool may suggest it was more likely a grinding tool used to process both plant and animal materials. It is also possible it was a multi-function tool that was used for knapping and for processing plant and animal resources. It could have been used to grind plant seeds or roots and could have been used to pound or grind rabbit meat or to fracture rabbit bone. Rabbit was taken by protohistoric and historic K'tunaxa people and the meat was consumed and pelts were used for clothing (Ray 1942 in Smith 1984).

A species of bovine was identified, along with rabbit, on the Warex/Avonlea projectile point. This artifact was recovered from Level 2 and likely does not associate with the protohistoric or historic periods. Bioarch, Inc. indicates that the two most likely species represented by bovine residue are bison and cow. Neither bison nor cow was identified in the faunal remains from 24LN1045. Bison was not found among the faunal remains recovered during the LAURD project. Bison is infrequent in archaeological sites west of the Continental Divide in Montana but is reported (Aaberg 1985). The Kootenai River in the project area is not considered prime bison habitat although certainly the grasslands of the Tobacco Plains, not far to the north of Rainy Creek, could have supported bison. It is also known that the protohistoric and historic K'tunaxa/Kutenai Indians at times traveled to the east side of the Continental Divide for bison hunting opportunities. It is possible that prehistoric peoples of northwestern Montana followed this same pattern of occasional ventures to the east on bison hunting trips.

Residues from plant species of two families were identified on three tools. Capparaceae (caper family) residue was found on a unifacial knife and on a large mano or pestle. In Montana, there are only two genera in the caper family: *Cleome* (bee plant) and *Polanisia* (clammy weed) with two species of bee plant (*C. lutea* and *C. serrulata*) and one species (*P. trachysperma*) of clammy weed (Dorn 1984). Only two of those three species grow west of the Continental Divide: *C. serrulata* (Rocky Mountain bee plant) and *P. trachysperma* (clammy weed). Neither of the species is known to have had economic importance of any sort among tribes now present, or historically present in Montana. Both species were used for food, in medicine, as dyes, in paint, and other applications by various tribes of the American Southwest, the Northwest Coast, and the Great Basin (Moerman 1998). Although all parts of the plant were used, the seeds of bee plant were often the focus for food. Among the Acoma, Keres, and Kerasan the seeds were cooked, dried and made into a porridge (Moerman 1998:169). The Isleta and Jemez ground the seeds into flour for making bread and cakes (ibid.). The plant was a staple with various food uses among the Pueblo (ibid.). It is interesting to note that among many of these tribes, grinding of the seeds was a routine activity associated with processing for consumption. It is possible that Rainy Creek occupants were using ground bee plant in some form as a diet supplement. Because references to use of these plant species are not found in historic and ethnohistoric documents does not preclude their use during prehistoric or protohistoric times.

Residue from a chenopod were found a long cobble that appears to have functioned as a mano or grinding stone although wear is minor. There are 16 genera in the Chenopodiaceae family represented in Montana and these include *Atriplex* (saltbush), *Axyris* (Russian pigweed), *Bassia* (bassia), *Ceratoides* (winterfat), *Chenopodium* (goosefoot), *Corispermum* (bugseed), *Cycloloma* (ringwing), *Grayia* (hopsage), *Halogeton* (halogeton), *Monolepsis* (poverty weed), *Salicornia* (saltwort), *Salsola* (Russian thistle), *Sarcobatus* (greasewood), *Suaeda* (sea blite), and *Suckleya* (suckleya). Over 40 species are represented in these genera. Many genera and species are weedy plants and are prolific seed bearers, which made them attractive to native peoples as food sources.

The genus that was most heavily exploited by many North American Indians (as well as in Central and South America) was *Chenopodium*. Other genera such as *Atriplex*, *Cycloloma*, *Monolepsis*, *Salicornia*, and *Sueada* were popular food sources but species of *Chenopodium* reached such a level of importance in diet, that in some regions (e.g. American southwest, American east and midwest, Central America, South America) it was cultivated. The seeds of goosefoot have been demonstrated to be quite nutritious with higher levels of iron and potassium than many modern cereal grains. Seeds of *Chenopodium* are probably the most frequent plant macrofossil found in archaeological sites across North America including Montana. Interestingly, species of goosefoot did not figure prominently in the diets of historic tribes of the northwest Plains and northern Rocky Mountain region. The Sioux, Northern Cheyenne, and Shoshone did exploit species of goosefoot, but that was primarily for the greens, which are rich in Vitamin A and C (just as with their close cousin - domestic spinach). A very common method for preparing goosefoot seeds in many areas of the New World was grinding them into a meal, from which cakes, porridge, and bread were made (Moerman 1998). It seems more than coincidence that *Chenopodiaceae* residue would be found on what appears to be a grinding tool from 24LN1045. The fact that goosefoot does not appear prominently in ethnobotanies of area Native Americans does not preclude the possibility that the plant was used as a dietary supplement by prehistoric or protohistoric peoples of Rainy Creek.

Obsidian Source Analysis

Three specimens of obsidian were submitted to Geochemical Research Laboratory (GRL) for sourcing analysis. Only two of those specimens were large enough to allow for analysis. GRL uses energy dispersive x-ray fluorescence as the analytical method for determining source (Hughes 2001: Appendix D, this report). Trace elements in the Rainy Creek specimens were identified and their ratios were compared to elemental content of control samples of obsidian from various sources throughout North America. Trace element concentrations and certain ratios indicate that one of the Rainy Creek specimens came from Obsidian Cliff in the Wyoming portion of Yellowstone National Park. The other specimen was sourced to the Malad, Idaho obsidian source.

The authors are not aware of earlier obsidian sourcing results for the Middle Kootenai River region. As far as is known the Rainy Creek obsidian specimen is the first Montana occurrence of Malad, Idaho obsidian. The Malad source is in extreme southeastern Idaho near Pocatello and within about 40 miles of the Snake River. Obsidian Cliff obsidian is common in archaeological sites throughout Montana.

It is of interest that two obsidian specimens from Rainy Creek came from areas some distance to the south. The Malad source is about 500 miles, as the crow flies (probably closer to 700 miles by land), from the Rainy Creek site and Obsidian Cliff is over 350 miles distant. Other archaeologists working in the northwest Montana tend to stress the presence of lithic material perceived to come from northerly stone sources at sites in the Kootenai River area (Choquette 1975, 1984, 1987; Choquette and Holstine 1980; Reeves 2000). Presence of obsidian from distant southerly sources would suggest that trade systems entering those areas were established long ago by occupants of the Kootenai River in northwestern Montana. Archaeologists and anthropologists have for some time suggested that historic Indians of northwestern Montana exhibited traits of both the Plateau and Plains areas. Earlier in this report (see Typlogical Crossdating) projectile points recovered from Rainy Creek were described. One of the points was found to be almost identical to Harder Phase points of the Lower Snake River area or to Columbia Valley points. The presence of this point and the presence of Malad obsidian tends to suggest there was interaction among the peoples of northwest Montana and peoples of the Plateau and Snake River areas.

The distance of these obsidian sources from the Kootenai River region also suggests that caution should be used in ascribing particular sources to some lithic material, in the absence of some form of geochemical analysis. Cherts and chalcedonies are extremely widespread in western North America and particularly in Montana. Cherts and chalcedonies from single sources also display extreme variation in color and structure. Cherts and chalcedonies found in the lithic assemblage from Rainy Creek could have come from great distances, just as did the obsidian.

MIDDLE KOOTENAI RIVER SUBSISTENCE MODELING

by

William P. Eckerle, Stephen A. Aaberg, Rebecca Hanna, and Sasha Taddie

Previous Models

Roll and Henry (1982) presented a subsistence model for the Middle Kootenai River Valley (MKRV). This model is based on Montana State University (MSU) excavations conducted during the Libby Additional Units and Reregulating Dam (LAURD) archaeological investigations. The MKRV is included within the Barrier Falls portion of the Northern Plateau archaeological area (Roll ed. 1982). Roll suggested the areas occupants utilized a seasonally-scheduled subsistence round as they exploited a variety of relatively dispersed plant and animal resources in the uplands during the warm months with shift, during the cold months, to the exploitation of deer (*Odocoileus* sp.) herds which concentrated on winter range, primarily lower, south-facing canyon slopes.

The Center for Northwest Anthropology (CNA), in conjunction with investigations in Lake Koocanusa (Thoms and Schalk 1984) postulated that Roll's model applied best to the Early and Middle Prehistoric periods. They suggested that during the Late Prehistoric period, multi-season occupation of the inner valley predominated as subsistence shifted to a year-around broad-spectrum base. For evidence of this change, they cite the increase in the number of valley bottom sites dating to the Late Prehistoric period. Further, they hypothesize that this settlement shift resulted from population growth that was facilitated by intensification on two fronts: first, the use of burning to increase big game forage; and second, the widening of diet breadth to include resources with lower return rates. Finally, CNA suggested that a forager, rather than a collector settlement strategy (see Binford 1980) was emphasized. Thoms and Schalk (1984) make a case for increased frequency of forest fires during the Holocene. They also make a case for increased use of lower ranked resources. However, their arguments for the reduced emphasis of logistical procurement during the Late Prehistoric are unconvincing. Implicit in their presentation is the argument that as women's resources increase in importance, logistical mobility will be reduced. In fact, as Kelly and Todd (1988) point out, the reverse is often the case, in that when residential mobility is reduced because of increased reliance on women's resources, male logistical mobility generally increases to facilitate hunting success.

It is also likely that evidence presented by CNA for the increased use of river terrace sites during the Late Prehistoric may be a function of geomorphic rather than cultural processes. Cochran and Leonhardy (1982) investigated the fluvial geomorphic sequence as part of the LAURD project. Their work indicates that the most widespread terrace (T2) had ceased aggrading sometime in the late middle Holocene, a change that allowed a well-developed soil to form. Accepting this observation, overbank deposition occurring before 3000 B.P. might have buried earlier occupation zones. This would reduce the opportunity for repeated reoccupation of a surface that was stable over a long period. It follows that stability of the T2 terrace surface after 3000 BP could create the illusion of a pattern of repeated reoccupation exclusive to the Late Prehistoric period if it were assumed that surface and near-surface archaeological materials associated only with that period.

Some post 3000 BP subsurface occupation zones were sampled during subsurface investigations undertaken during the LAURD project. As suggested above, the stabilization of the T-2 terrace tread prior to the Late Prehistoric period could have made portions of the T-2 terrace tread available for reoccupation many times, with little or nor stratigraphic separation of those occupations. This surface stability could have resulted in the formation of large, complex, and highly visible, near-surface sites. Such site types were found during the LAURD excavations indicating geomorphic processes played a role in the false impression of a Late Prehistoric record characterized by a more residentially settled and larger population than was present in the valley during earlier periods. In addition, late middle Holocene and late Holocene horizontal aggradation has probably removed some of the T2 sediments that formerly contained occupations older than 3000 years. Thus, there is likely disproportionate preservation of younger occupations giving the false impression of larger populations and more intensive use of the river valley during the Late Prehistoric.

Paleoenvironmental Modeling Based On Rainy Creek Site Research

Introduction

Deer winter range has been seen as a crucial variable in both the LAURD and CNA excavation projects. Currently, the valley bottom is within, and proximal to, excellent deer winter range. However, there has been little discussion of the variability of deer winter range over time, especially with respect to pre- versus post-Late Prehistoric times. This is important for understanding the environmental constraints that might have affected prehistoric subsistence in the valley. Although many of the excavated sites in the area contain deer bone, the chronological and contextual control of some of these sites is less than ideal. Many of the excavated upland sites like 24LN1045 are severely turbated by tree tip-out processes. In addition, excavated site samples are small. Because of the limitations of the archaeological record attempts are made herein to analyze the variability of deer winter range through time using paleoenvironmental modeling. A prime component of this analysis is the use of an archaeoclimatic model (Bryson, this volume, Appendix C). This model predicts temperatures and precipitation change over the span of the Holocene. In the following discussion, Bryson's modeled climatic data is input to a winter range model that also combines modeled snow accumulation period and vegetation ecology. These three variables are used to model changes in deer winter range through time and offer suggestions as to how these changes might have affected the occupants of the middle Kootenai valley.

Archaeoclimatic Model

Bryson (Appendix C) has proposed changes in temperature and precipitation over the course of the Holocene. This model relies on earth-sun geometry as well as predictions of climatic change generated by the variability of volcanic aerosols over time Bryson (1994). This model also utilizes historic weather data to ground the predictions in the range of known variability. An archaeoclimatic model was generated for the Libby, Montana area. Temperature and precipitation predictions were compiled for the last 14,000 years (Figures 75 and 76). The model also characterizes seasonal trends between temperature and precipitation through time. Bryson's' modeled data is based on a valley location, a variable that was considered in developing the model proposed herein.

Water Budgets and Soil Moisture Deficit Calculations

In this report, some of Bryson's data (predicted monthly temperature and precipitation) is used to calculate water budgets using a computer program called ThornPro (Black 1996). Water budgets for 200 year intervals are calculated from Bryson's modeled temperature and precipitation data. This allowed plotting and evaluation of modeled soil moisture deficit over time (Figure 77). Increased soil moisture deficit results in a more xeric landscape while a reduced soil moisture deficit yields a more mesic landscape. Figure 78 presents modeled soil moisture deficit as percent deviation from present, which is given a value of 100%. Percentages greater than 100% indicate increasing aridity while percentages lower than 100% indicate more effective moisture. Note that the modeled soil moisture has only a moderate correlation with local and regional environmental reconstruction.

Snowfall Accumulation Period Estimates for the Last 10,000 years

Data generated by Bryson's archaeoclimatic model also allows for predictions of variability in the duration of the snow accumulation period, over time. The snow accumulation period model was adapted from Whetton et al. (1996); Galloway (1989); Braithwaite (1984). The model predicts the duration of snow cover using mean monthly temperatures, a measure of the variability of monthly temperatures, and monthly precipitation.

Observed relationships are used to estimate monthly snowfall and potential ablation, providing a way to calculate the snow accumulation period.

Snowfall accumulation period (SAC) in days is:

SAC = monthly snowfall - monthly ablation.

As given by Whetton et al. (1996) monthly average snowfall is: $S = \alpha P$.

P is the monthly average precipitation and α is the proportion of precipitation falling as snow. An accurate calculation of snowfall accumulation period requires the "monthly standard deviation of daily temperature". Historic records from 1961 through 1990 are used to determine daily temperature measurements. Using Bryson's modeled paleo-data set, it is assumed that "monthly standard deviation of daily temperature" has not varied over the course of the Holocene.

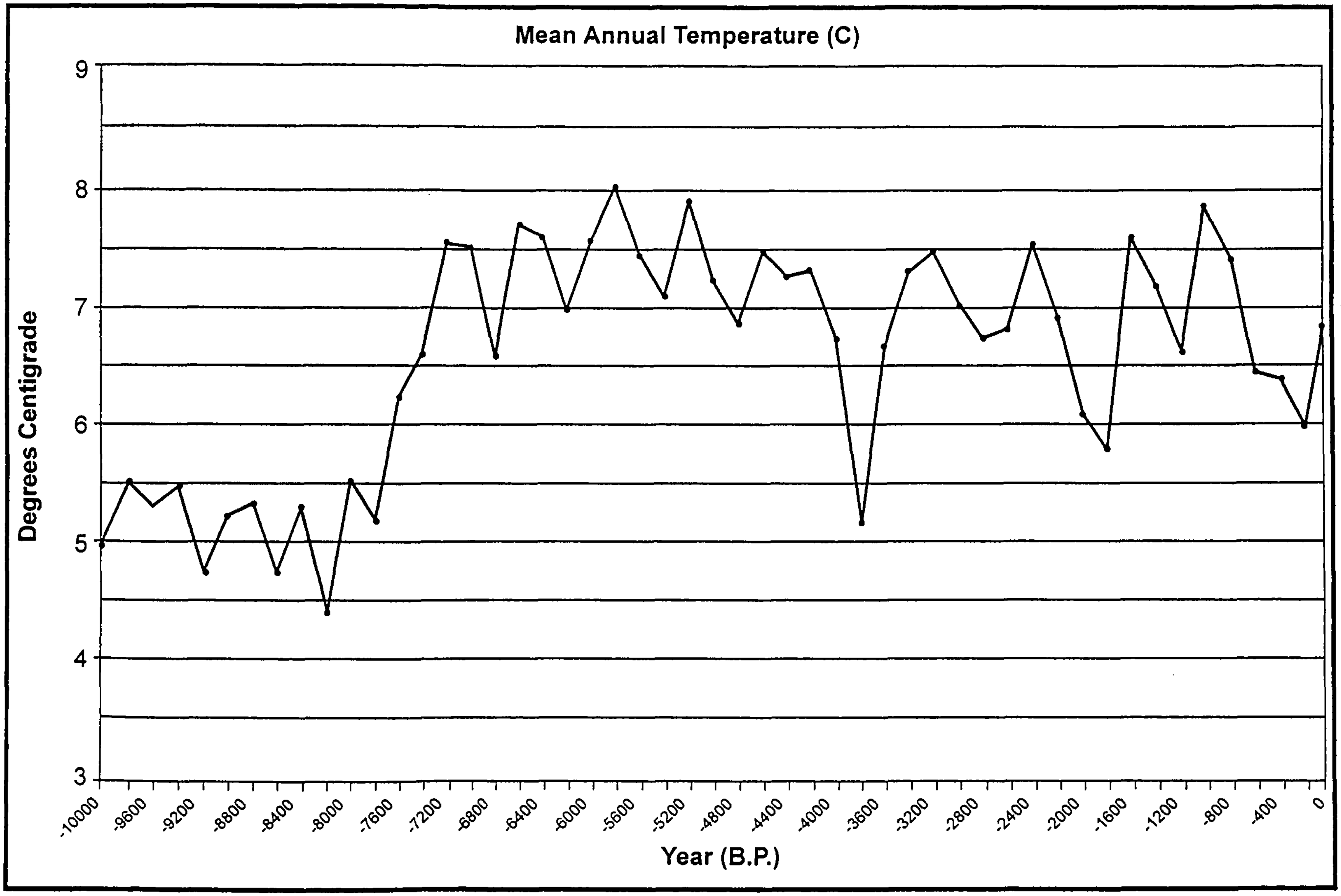


Figure 75: Modeled temperature for the Libby, Montana vicinity (from Bryson, Appendix C, this volume).

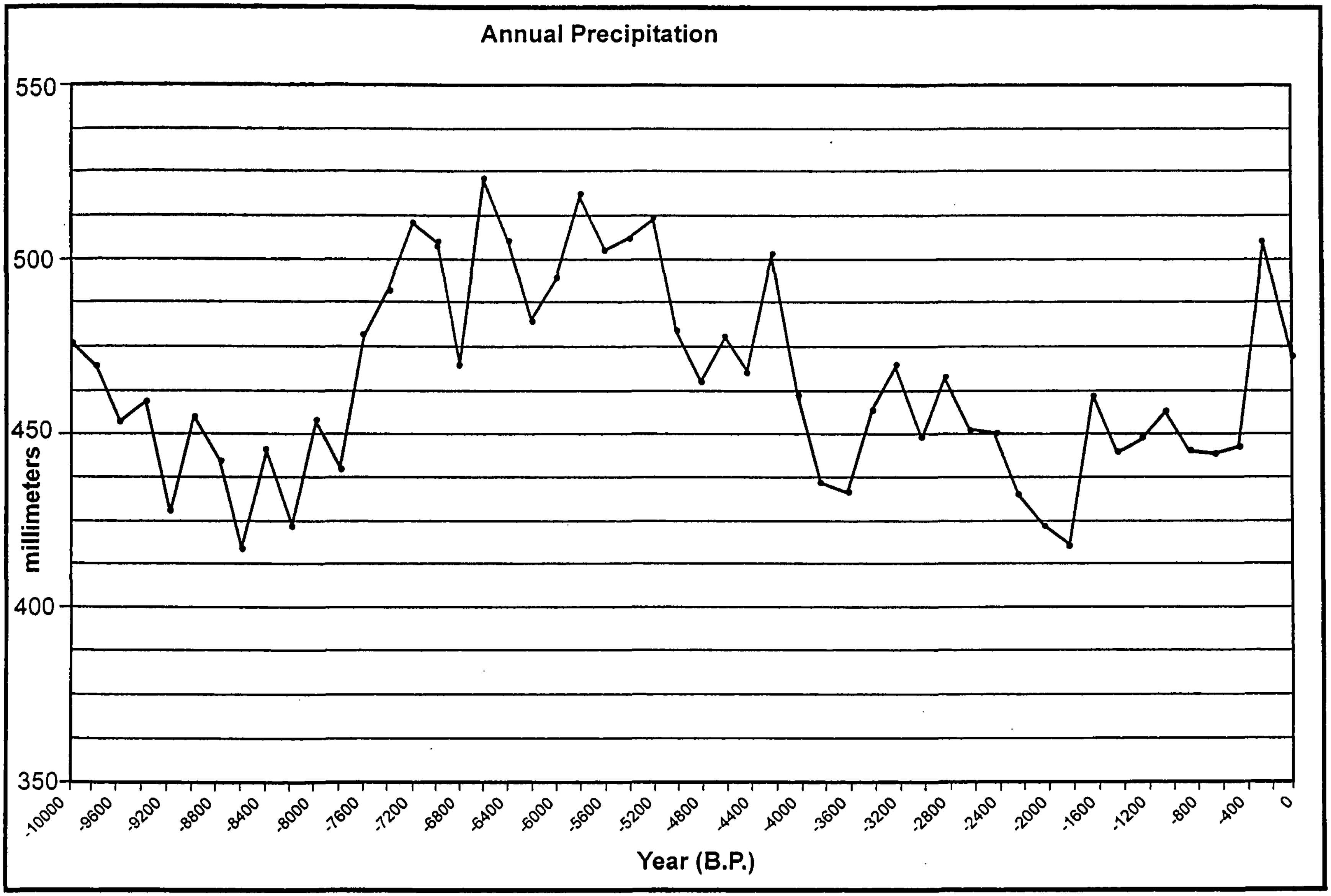


Figure 76: Modeled precipitation for the Libby, Montana vicinity (from Bryson, Appendix C, this volume).

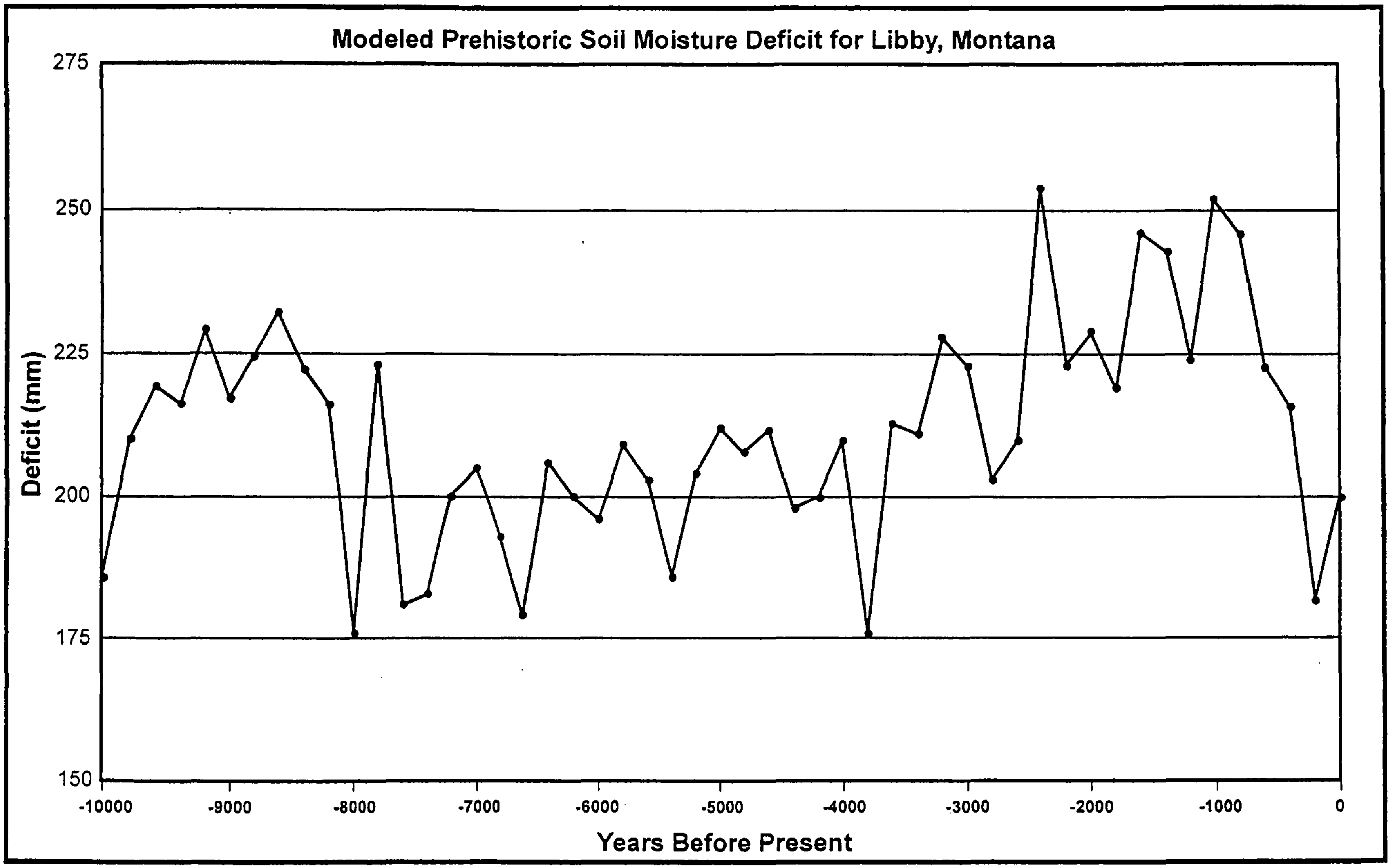


Figure 77: Modeled soil moisture deficit for the Libby, Montana vicinity. Input data from Bryson, Appendix C, this volume.

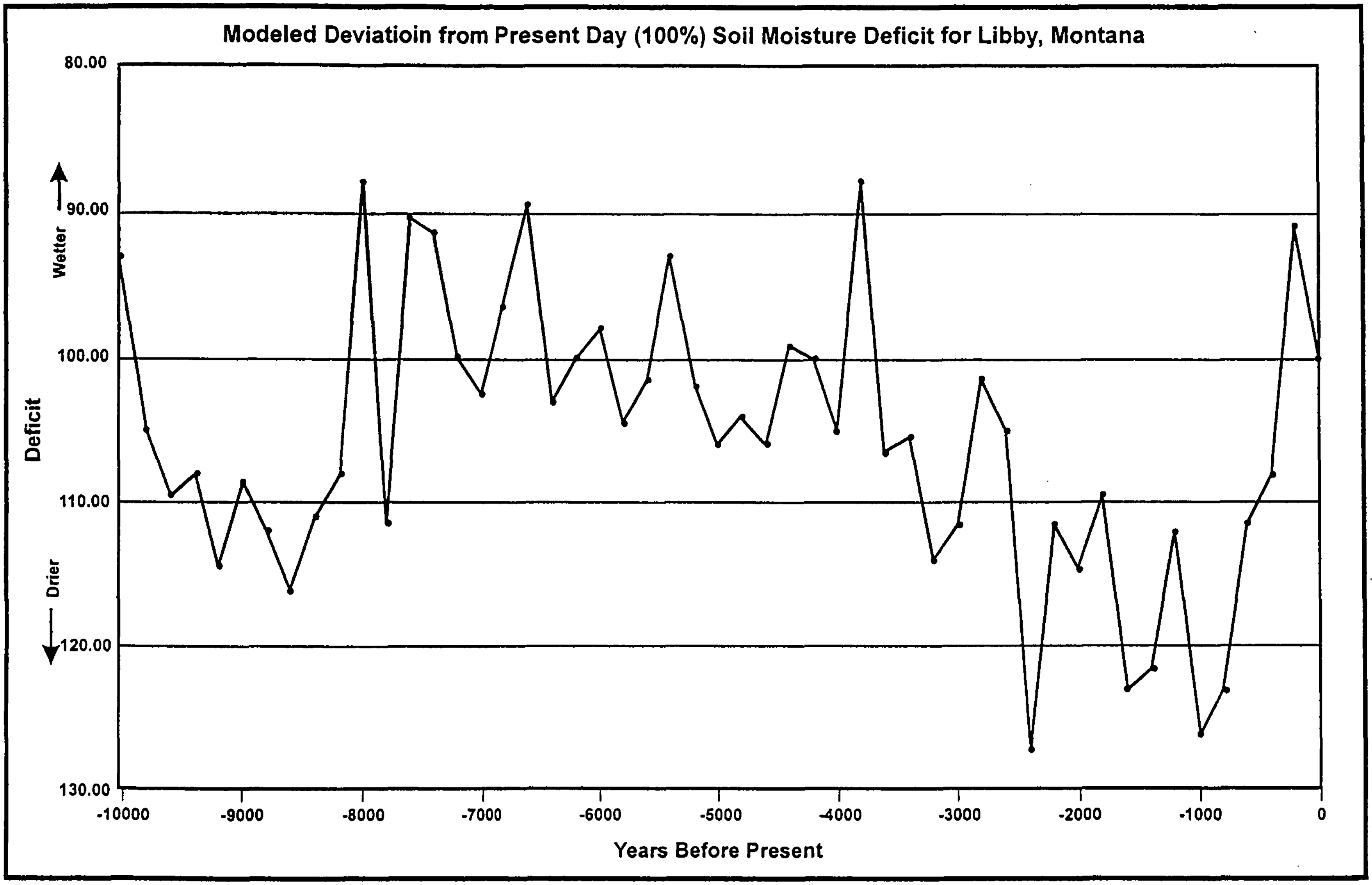


Figure 78: Modeled soil moisture deficit as percent deviation from present for Libby, Montana vicinity. Input data from Bryson, Appendix C, this volume.

Our methodology also required interpolating a line graph for the determination of "α" (alpha). Four data points, combined from Whetton et al. 1996, and Linacre, E. and R.W. Galloway (1998), were used to construct this graph and allowed plotting the correspondence of "temperature" to "percent precipitation as snow". From those four points we interpolated a smooth/normal curve that passes through the four given points, thus creating the continuum to estimate an associated, required, "percent precipitation as snow" factor.

Potential ablation is calculated by Whetton et al. (1996) as: $A = \beta\gamma\ D/n$ wherein D represents degree days above 0 (C^{O}) for the month and "n" is the number of days in each month. "β" is a degree day factor. "γ" is absorptivity factor representing the variation of the reflectivity of the snow. Degree days are estimated using Braithwaite (1965).

Several assumptions were accepted for estimating potential ablation in this report. irst, the degree-day factor ("β") has been set to it's median value of 3.2 mm/^{O}C day as determined by Todd (1970) who presented estimates based on 13 field and laboratory determinations. Second, the absorptivity factor ("γ") has been set to 1 (see discussion in Whetton et al. 1996). Finally, graphs were plotted for monthly accumulation and monthly ablation and were used to interpolate the snowfall accumulation period to days, as shown by Whetton et al. (1996).

Figures 79 and 80 indicate variability in the accumulation period of snowfall over time. Given the long-term, westerly source of winter moisture for the study area, we suggest that snow accumulation season duration is a good proxy measure of snow pack thickness. This information is used below to inform our modeling of deer winter range.

Inspection of Figure 80 indicates that there has been considerable variation in the snow accumulation period over time. A number of snowfall accumulation period regimes can be characterized in terms of percent of present-day snow duration: "similar to present day" (90-110% of present), "greater than present day", "less than present day", "much less than present day". Snowfall accumulation period was within the normal range for a significant proportion of the post-7000 B.P. era. In general, snow accumulation periods occurred during the early Holocene 10,000-7200 B.P. and ~7000 B.P. and at three peaks during the Neoglacial: ~3800 B.P., ~2000 B.P., and ~400 B.P. The last three of these are Neoglacial in age with the very last, corresponding to the Little Ice Age. By contrast, the snow accumulation period was greater than present for much of the mid-Holocene between 6000 B.P. and 4400 B.P. as well as during a fair proportion of the late Neoglacial between 2600 B.P. and 800 B.P. (excepting the moist spike at ~2000 B.P.). The only times that snowfall duration was much lower than normal was during the Late Neoglacial at ~1600 B.P. and ~1000 B.P. respectively. Interestingly the snowfall duration model mimics proposed paleoclimatic reconstruction, as presented by both Roll (1982), Thoms and Burtchard (1987.), and Mack et al. (as summarized in Bryson - Appendix C), better than does soil moisture deficit (Figure 78), or precipitation less evaporation modeled by Bryson (Appendix C). This suggests that for the Libby area, paleo-snowpack is a better environmental proxy than soil moisture or effective precipitation. Thus, snowfall duration is used to help inform our model of deer winter range.

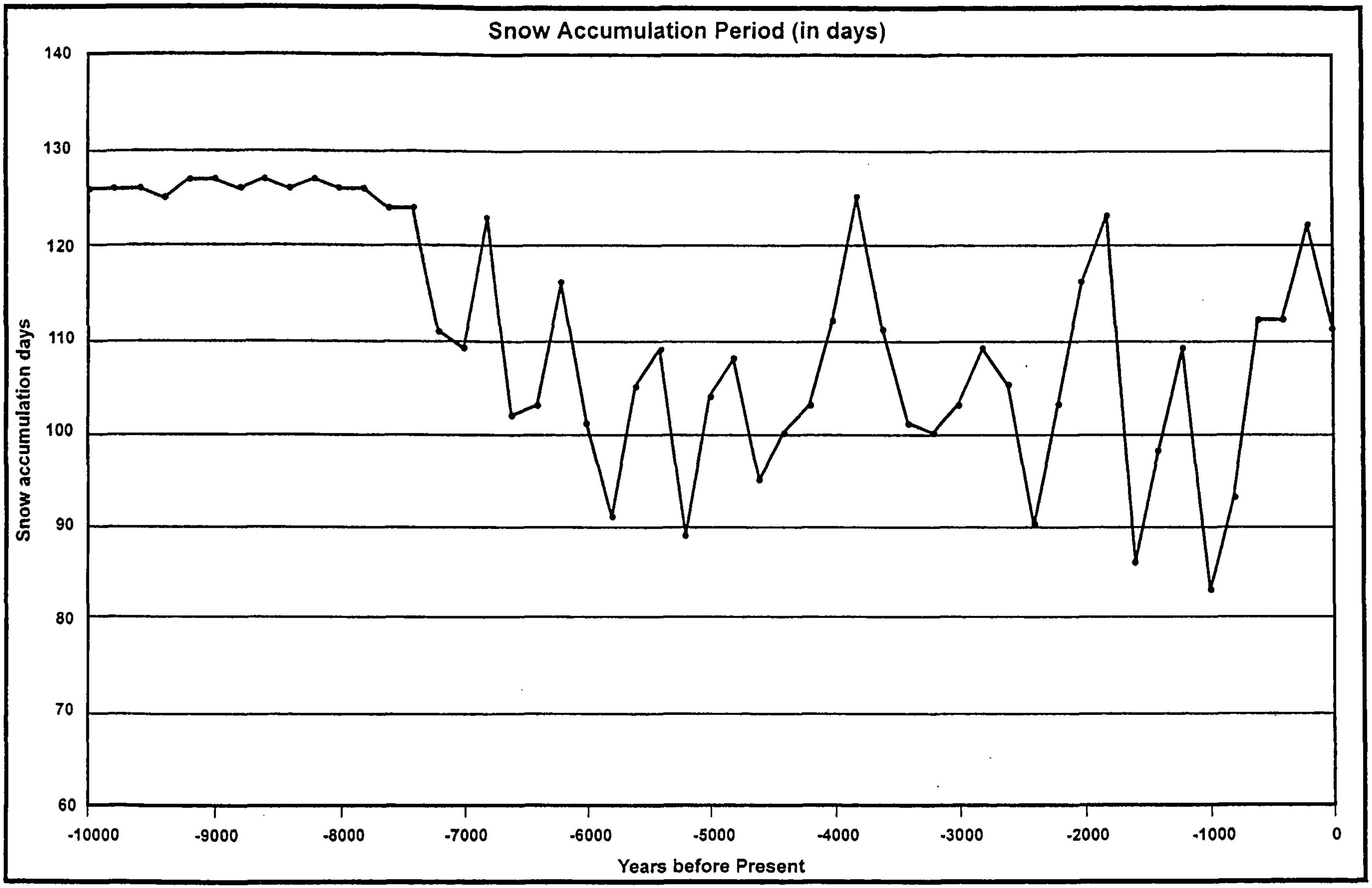


Figure 79: Modeled snowfall accumulation period for Libby, Montana vicinity.

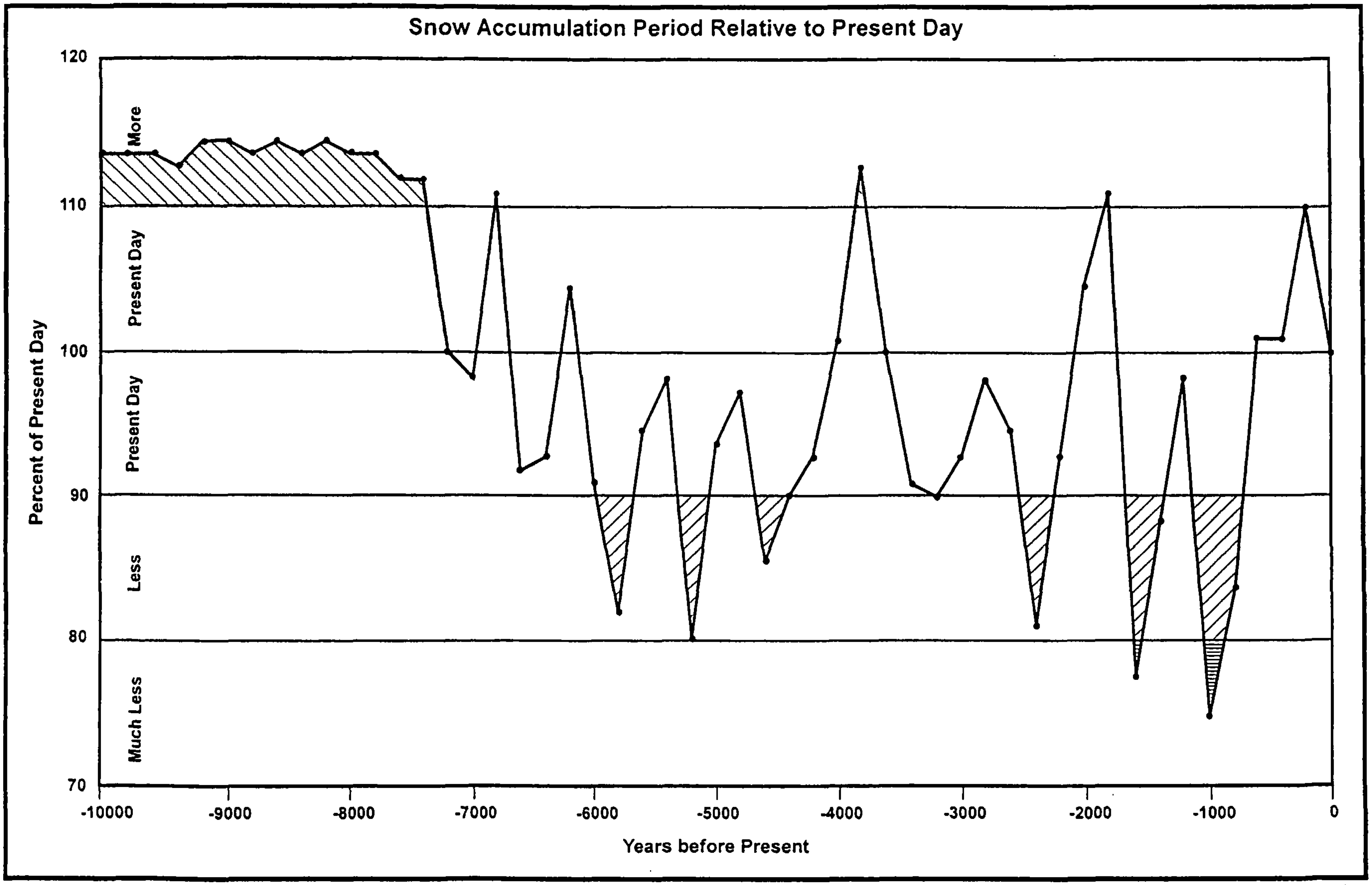


Figure 80: Modeled snowfall accumulation period as percent deviation from present for the Libby, Montana vicinity.

Ecological Modeling

The Middle Kootenai River valley is surrounded by land managed by the U.S. Forest Service. Recent interest in ecological-based forest management has resulted in an integration of habitat type mapping with a broader understanding of fire history and ecological succession. New understanding gained by this integration has resulted in the "vegetation response unit" concept (Kootenai National Forest 1999). A vegetation response unit (VRU) is a unit of "... basic environmental stratification for relating repeatable landscape patterns to predictable ecological processes." (Kootenai National Forest 1999:1). A VRU is based on historic species composition, stand structure, fire regime, and patch size (Kootenai National Forest 1999) as informed by palynological studies (Chatters 1995; Chatters and Leavell 1994). Climate, as mitigated by elevation, is the primary determinant of VRU status. The Kootenai National Forest is mapped using a sequence of 11 VRU's which exist along a climatic gradient and these VRU's are given verbal modifiers ranging from "Warm and Dry" (1) to Cold (11) (Appendix A; Table 12). Text descriptions of the VRU's provide various categories of information including precipitation range, elevation range, landform type and predominant plant species and these are summarized in Appendix A; Table 12.

As mentioned above, snowfall accumulation period seems to track paleoenvironmental local reconstructions better than does soil moisture deficit. Because of this, duration of snowfall accumulation period over the last 10,000 years is used to propose some changes in the occurrence of the vegetation response units along the cold/wet to warm/dry sequence (Figure 81). As cautioned earlier in this discussion, the modeled climate is based on a valley location (Libby, Montana). It is therefore possible that climatic modeling posed herein will not reflect paleoclimatic variation at higher elevations.

It is suggested that, similar to present-day conditions, a climatic/elevation gradient determined the series of VRU's, which existed in the past. However, the VRU of a particular location during the past could have varied from the one extant in modern times. It is difficult to gauge the response of ecological units to changing past climates but a working hypothesis is proposed below.

It is suggested that, for the "greater snowfall accumulation period than present" and the "less snowfall accumulation period than present" regimes, the VRU of a particular landscape would have shifted up or down to the next nearest VRU within the modern vegetation response unit series. This is illustrated in Appendix A; Table 13 where VRU's are assigned an upper case letter designation and indicate the predicted relative change of "less..." and "greater snowfall accumulation period than present" regimes. As well, it is not unreasonable to suggest that a shift of 2 VRU's to a warmer/drier regime would have occurred within the modeled "much less snowfall accumulation period than present" eras. This is similarly indicated on the table. This shift in VRU's can be illustrated in a series of 4 map panels showing the suggested distributions of VRU's during modern, greater snowfall accumulation period, less snowfall accumulation period than present, and much less snowfall accumulation period than present eras (Figure 81).

Change in Deer Winter Range Over Time

Vegetation response unit descriptions include a characterization of a VRU's deer winter range value (Appendix A; Table 12). VRU's 1 and 2 (our C and D respectively) are considered

Color Chart(s)

The following pages contain color that does not appear in the scanned images.

To view the actual images, please contact the Superfund Records Center at (303) 312-6473.

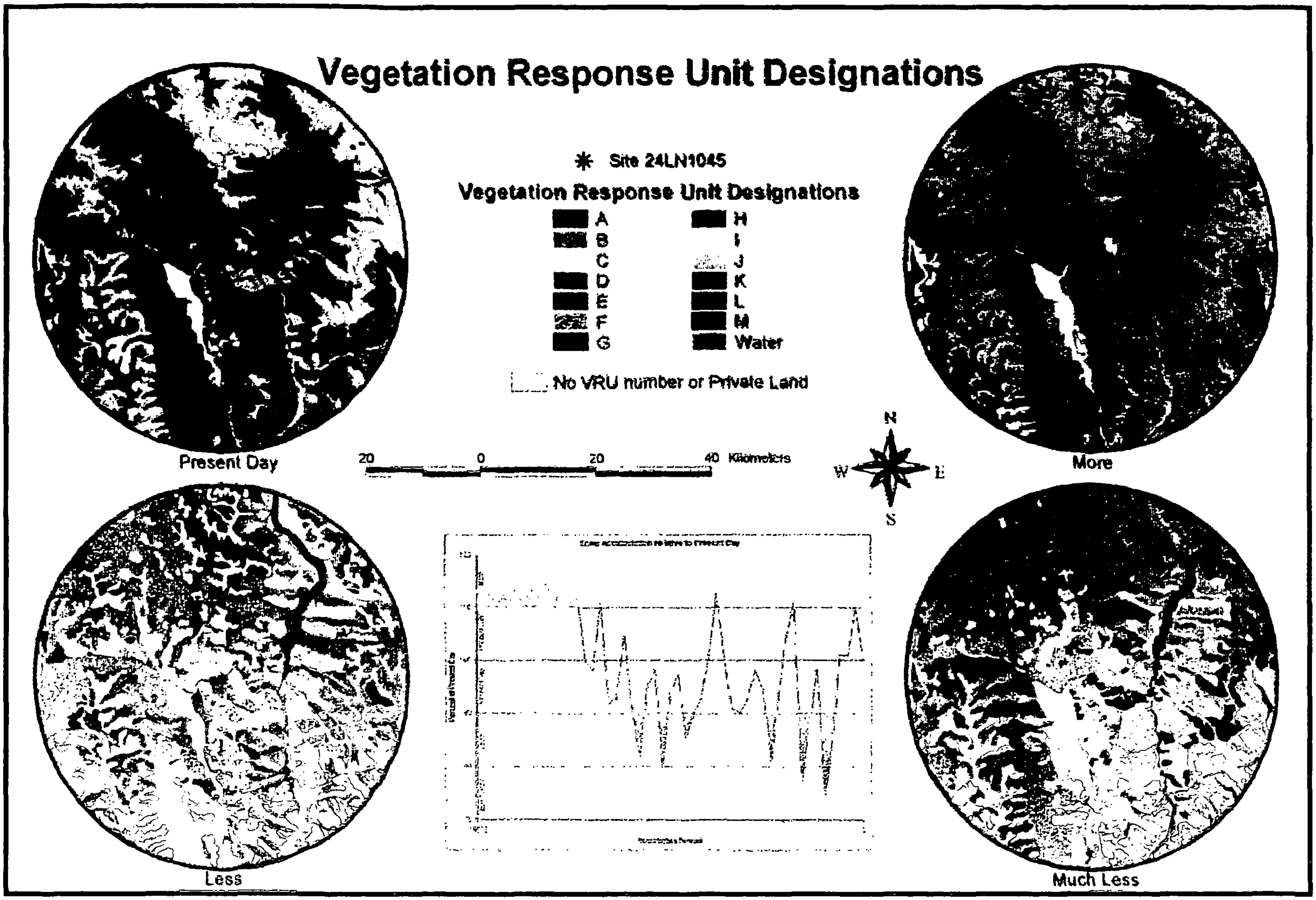


Figure 81: Distribution of vegetation response units (VRU's) for modern, greater, less, and much less snowfall accumulation period than present (base map from the Kootenai National Forest 1999).

to be "primary" winter range. Whitetail deer are more common in VRU 1 (C) whereas, both whitetail and mule deer are mixed within VRU 2 (D). Deer tend to utilize arboreal areas within these two VRU's during periods when snow depth exceeds 18" (Kootenai National Forest 1999). It is suggested here that climatic and vegetation conditions during both the less and much less snowfall accumulation periods would have produced landscapes, which provided expanded deer winter range (Figure 82). As modeled, during the "less snowfall than present accumulation" eras, VRU's 2 (our D), 1 (our C), as well as VRU B could conceivably have provided primary winter range for deer. VRU A would have joined these three during the "much more" era. Snowfall accumulation period (and soil moisture deficit) might have been a limiting factor on the predominantly nonarboreal vegetation in VRU' A and B.

Given the analysis, Figure 82 illustrates the changing extent of winter range over time based on the factors discussed above. It suggests that significant expansion of deer winter range probably occurred during the "less snowfall accumulation period than present" eras with additional further expansion during the "much less snowfall accumulation period than present" eras. Inspection of Figure 82 illustrates the general restriction of deer winter range during the early Holocene. It also appears that deer winter range was generally the same as present or expanded after 7000 B.P. except for a few "Neoglacial" spikes when it was reduced to levels similar to those of the early Holocene. Interestingly, the Little Ice Age (600-100 B.P.), which coincides with the latest Late Prehistoric and Protohistoric periods, was an era of generally reduced deer winter range.

Inspection of Figures 78 and 80 suggests that increase in anthropogenic burning, hypothesized by Thoms and Burtchard 1987), occurred during two of the driest periods of the Holocene. It is therefore possible that the evidentiary pattern for increased burning during these intervals was the result of severely depressed soil moisture.

Implications For Middle Kootenai River Settlement and Subsistence Modeling

The model proposed above suggests that deer winter range throughout the middle Holocene, after about 7000 BP, expanded in middle Kootenai River valley bottom settings and would have provided optimum habitat for deer populations. The archaeological record from 24LN1045 tends to agree with this posed model. Although excavation at the Rainy Creek Site was limited, all areas of the site, particularly on the south side of Rainy Creek were at least sampled. As described in earlier sections of this report, occupation of Rainy Creek appears to have been intense and repetitive from at least 2000 years ago. Radiocarbon dates and diagnostic artifacts recovered from excavation units placed on the alluvial fan are dominantly associated with the late Middle Prehistoric Period (Roll's Kavalla Phase) and Late Prehistoric Period (Roll's Stonehill, Warex, and Yarnell Phases). There is some indication that occupation intensified at the end of the Middle Prehistoric Period and the beginning of the Late Prehistoric Period based on distribution of heat-altered rock and bone. There are also indications that occupation was not as intense during the late Late Prehistoric Period and the Protohistoric Period. Both bone and heat-altered rock reach a peak in level 2 across the site and diminish considerably in level 1.These materials were also less frequent in levels 3 and 4 but were still much more abundant than in level 1.

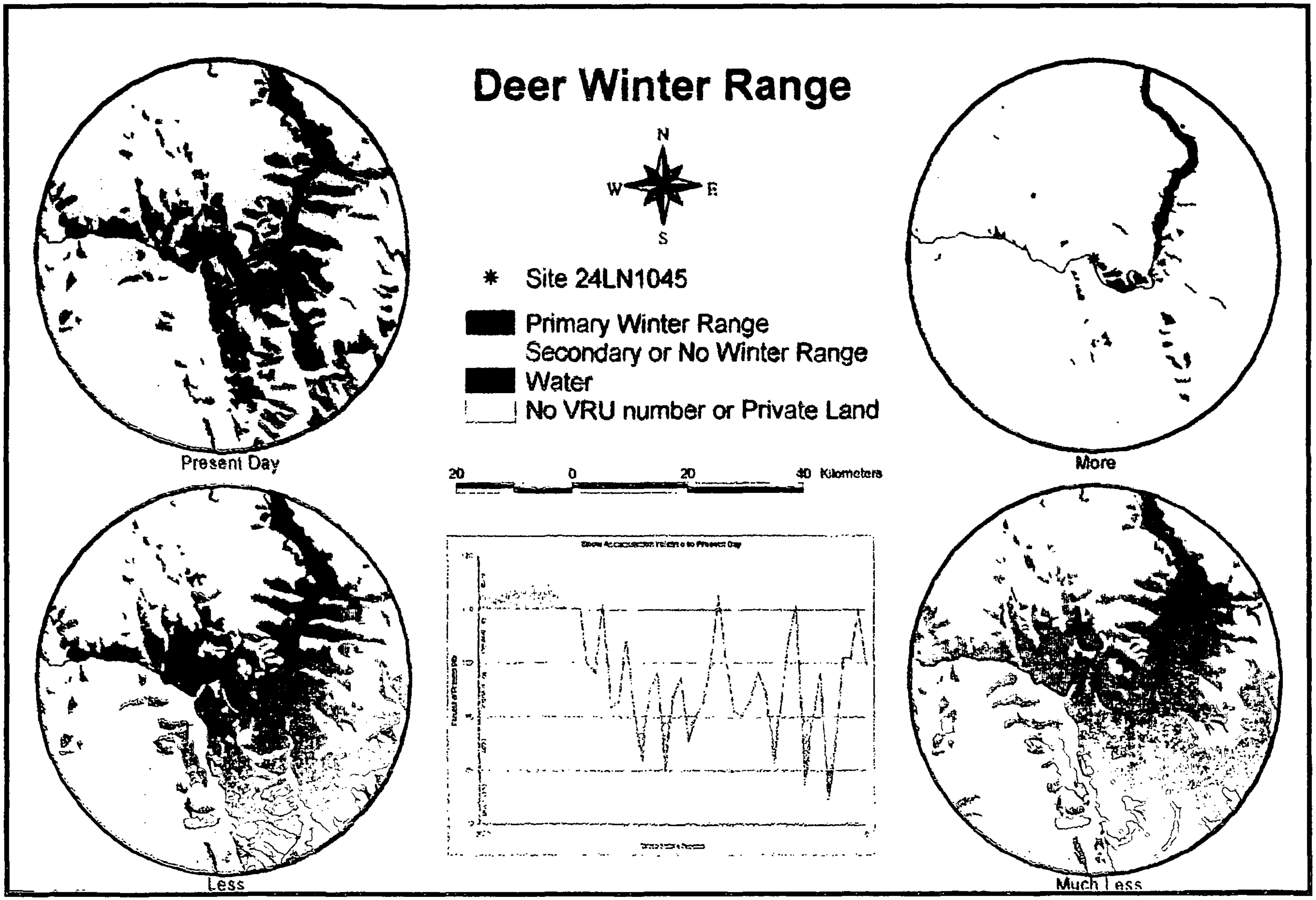


Figure 82: Distribution of deer winter range for modern, greater, less and much less snowfall accumulation period than present (base map from the Kootenai National Forest 1999).

Two deeply buried occupations dated to about 2800 BP and 3700 BP were identified in backhoe trenches at Rainy Creek. Unfortunately, these occupations could not be sampled through hand excavation because of constraints posed by asbestos remediation. A small sample (± 2 gallons) of the 3700 year old occupation was screened and suggests that both heat-altered rock and bone from deer-like animals (medium ungulate) are frequent. Because neither of these older occupations were sampled by hand excavation it is presently impossible to determine if multiple archaeological cultures are represented by artifactual remains or if a single culture is represented. In any case, these older archaeological deposits document occupation of the Middle Kootenai River valley bottom during middle Holocene times. The faunal record in all levels from 24LN1045 is dominated by medium ungulate or deer-like species with no indication that diet breadth, as expressed by the presence of varied species, increased in the Late Prehistoric Period.

The immunological record indicates exploitation of rabbit by site occupants but does not necessarily imply increasing diet breadth. The settlement model posed herein, which is based on deer winter range availability and change through time, does not suggest an emphasis on deer during winter occupations to the exclusion of other food resources. Rather, it suggests that site selection was seasonally driven by predictable distributions of high return resources such as deer. Our model also suggests that large populations of deer would have been predictably distributed in the middle Kootenai River valley throughout the middle and late Holocene during winters when critically necessary range was available in that setting. Deer winter range habitat in the Kootenai valley obviously is good habitat for other species like rabbit (commonly sighted within 24LN1045 during the 2000 field season). Certainly an abundant resource such as rabbit would not have been ignored, particularly since energy investment for procuring such a species would have been relatively low (see Smith 1984 for rabbit trapping/hunting techniques).

The deer winter range model presented herein does not suggest that the Kootenai River valley was not occupied during other seasons. Certainly other resources such as berries and possibly fish would have been seasonally exploited. Procurement of other resources, particularly plants such as camas and bitterroot, so important to historic tribes of the area, would have required leaving Kootenai valley bottom settings. Our model does suggest that those numerous valley bottom sites represented by dense "middens" of heat-altered rock and deer-size bone occur because of winter deer-procurement strategies.

INTERPRETIVE AND ANALYTICAL SUMMARY

by
Patrick Walker-Kuntz and Stephen A. Aaberg

The significance of the data recovered from the Rainy Creek site is best realized when placed into a larger regional context. With this purpose in mind, the Rainy Creek data may be compared to results and conclusions from other projects conducted in Northwestern Montana, including the LAURD Project (Roll 1982) and some of the regional trends described by Reeves for the Waterton-Glacier area (2000). The LAURD Project, conducted by MSU, included inventory and excavation data from several sites in the Kootenai Canyon (Roll 1982), and Reeves' work was similarly focused for Waterton-Glacier. Our conclusions are based on the results of data recovery at one site and the data set is, at the level of regional patterning, very small. However, the information collected from this site represents a significant contribution to the understanding of the middle Kootenai region prehistory.

The Rainy Creek site is located in the same general area as the LAURD project. Roll's project area was delimited by the lack of resources commonly associated with the surrounding areas, such as bison, camas, salmon, and caribou. Roll states that people using the middle Kootenai River valley seasonally focused on deer hunting. "Populations concentrated in the river bottoms (late winter-early spring) and dispersed at other times to utilize the various resource potential of additional life zones" (Roll 1982:iv). Data recovered from excavation indicated occupation of the canyon area from about 5,500 BP to 100 BP. Little change occurred in the subsistence system during this period despite climatic and vegetative changes through time. According to Roll, this was due to the versatility of deer (the preferred prey species), which tempered the cultural effects of environmental change that occurred over the ages.

Intense occupations of the Rainy Creek site began about 2000 years ago, toward the end of Roll's Kavalla Phase, Reeves' Pelican Lake Phase/Blue Slate Canyon Subphase, or Choquette and Holstine's Inissimi Complex. Post 2000 BP occupations heightened through Roll's Stonehill, Warex, and Yarnell Phases (Reeves' Crandell Mountain Subphase/Besant Phase, Tobacco Plains Phase/Old Women's Phase; Choquette and Holstine's Inissimi Complex, Transitional II period, Akiyinek Complex, Akahonek Complex) and into protohistoric and historic times. Although occupation began much earlier (by at least ca. 3720 BP), the nature of these earlier occupations cannot currently be characterized since they were not adequately sampled through excavation. The presence of two culture-bearing horizons that lay over one meter below surface suggests that even more deeply occurring, culture-bearing horizons or strata, could be present within the alluvial fan.

Although detailed faunal analysis for the Rainy Creek assemblage was not completed because of failure of the subcontracted faunal specialist to complete a report or return the bone, basic analysis completed by ACRCS suggests a focus on medium ungulate (likely deer) procurement and processing. This seems to be in keeping with Roll's settlement model although seasonality data would have strengthened the argument. The deer winter range model developed during Rainy Creek research was based on paleoclimatic data developed from historic records. The data and model also tend to support Roll's winter focus on deer.

The Rainy Creek projectile points demonstrate an extremely wide array of stylistic variations, even given the long history of site occupation. Projectile point styles associated with the Plains or Plateau exist at Rainy Creek in the context of locally adapted subsistence strategies. Roll's chronology of the area is used to illustrate these phases as local adaptations. "Explanations dependent on diffusion of traits or migration of people are simply expedients that ignore the enormous creative potential of indigenous people adapting to and modify their immediate environment (Roll 1982:5.8-5.9).

The earliest typeable projectile points from Rainy Creek were all found in Level 4 (30-40cm BS) in excavation units placed on the alluvial fan. They likely date to the late Middle Prehistoric Period or local Kavalla Phase. Two are similar to points attributed to the Kavalla

Phase by Roll (1982:5.12-5.13; Type 4), Pelican Lake Phase/Blue Slate Canyon (Reeves 2000), and in Harder Phase of the Lower Snake River (Leonhardy and Rice 1970). One specimen recovered from 42cm below surface is nearly identical to Roll's (1982:5.13) Type 6, a stemmed type that he also attributes to the Kavalla Phase. The Rainy Creek specimen is not classically stemmed but seems to exhibit technologic characteristics of both corner-notching and side-notching.

An unusual specimen recovered from Level 4 of unit S-1 defies typological classification. The point is ovate in body form and stemmed with a double set of shallow side-notches or serrations. Although this point looks nothing like the large corner notched points typically found in late Middle Prehistoric assemblages in the region, the stratigraphic context of this specimen suggests an association with the Kavalla Phase/Pelican Lake Phase/Blue Slate Canyon Subphase or Choquette and Holstine's (1980) Inissimi Complex.

The single projectile point recovered from Level 3 on the alluvial fan may be considered one of the late Middle Period corner-notched points. However, this specimen appears more similar to Columbia Valley Corner-Notched varieties (Caldwell 1960; Roll 1974:100, 103) of the Pacific Northwest. The point also resembles Harder and Piqunin Phase points of the Lower Snake River (Leonhardy and Rice 1970). Similar points were not found in the reports of the LAURD and CAN projects. Plateau and Pacific Northwest points mentioned above all associate with the Late Prehistoric Period, generally within the last 1500 years. The occurrence of this point, along with the identification of Malad, Idaho (very near the Snake River) obsidian, suggests some sort of contact between peoples of northwestern Montana and the Plateau region.

Point specimens recovered from Level 2 in units placed on the alluvial fan all appear to associate with the Late Prehistoric Period. One of these resembles points of the Avonlea Phase in the Plains sequence (Reeves 1983; Frison 1978/1991), Roll's (1982) LAURD area Warex Phase, Reeves' (2000) Crandell Mountain Subphase (local equivalent of Avonlea), and Choquette and Holstine's (1980) Transitional period and the Akiyinek Complex. Roll (1982) suggests a temporal range of A.D. 500-1200 for the Warex Phase while Reeves (2000) suggests a range of about 1600 to 800 BP (radiocarbon years ago) for the Crandell Mountain Subphase.

One thin and well-flaked unnotched point may be a form of Avonlea/Warex/Crandell Mountain (Reeves 2000). The Rainy Creek specimen appears to be more finely crafted and thinner than later triangular unnotched forms and is therefore attributed to the Warex/Avonlea phase.

The last Level 2 point is a reworked Late Prehistoric point but is not particularly diagnostic of a particular phase. The point is similar to Roll's Stonehill and Yarnell Phases or Reeves' Besant/Waterton River Subphase and his Old Women's/Tobacco Plains phases. The point may originally have had side-notches placed low on the blade, but reworking of the point has altered some of the original characteristics.

All point specimens recovered from Level 1 in alluvial fan units are simply too fragmentary to classify. The single projectile point recovered from the site surface in an undisturbed area on the north edge of the alluvial fan (north side of Rainy Creek) is corner-notched on one side and side-notched on the other. The point may be associated with the Warex/Avonlea Phase, but is also reminiscent of Roll's Yarnell Phase points or Reeves' Old Women's Phase/Tobacco Plains Phase (Roll 1982: 5.17-5.19). Temporal range for Yarnell/Old Women's/Tobacco Plains points is A.D. 1000 – 1800.

Four projectile points were recovered during monitoring and were not in context but came from a stripped zone extending from surface to about 24" below surface. Two of the specimens are side-notched arrow points and likely associate with the Yarnell/Old Women's/Tobacco Plains phase. The other two specimens are corner-notched and likely associate with the Kavalla/Pelican Lake/Blue Slate Canyon phase.

In summary, points representative of the Kavalla/Pelican Lake Phase, the Warex/Avonlea Phase, and the Yarnell/Old Women's Phase were recovered from Rainy Creek. Two anomalous points were also found with one reminiscent of the Harder Phase points of the Lower Snake River area or Columbia River Corner-Notched variety. The other unusual point does not fit a classificatory scheme found during research for this report.

The Late Period Phases, Warex (Avonlea equivalent) and Yarnell (Old Women's-Tobacco Plains) are well represented in the LAURD sites, which often contain mixed Warex and Yarnell Phase components. Reeves notes a significant shift in lithic use patterns between the earlier Kavalla and the later Warex and Yarnell phases. "Local silicified siltstones and argillites as well as Kootenay Argillite decrease in frequency, and are replaced by Top-of-the-World chert and a wider range of cherts" (Reeves 2000:431). Reeves considers TOW chert to be a phase diagnostic of Tobacco Plains.

Excavation Unit S-5 at Rainy Creek did not yield any projectile points or other diagnostic lithic artifacts. However, the unit did contain a hearth dating to the very Late Prehistoric Period or Protohistoric Period (ca. 320 BP). The relatively high frequency of TOW chert in the Unit may indicate that the material found in this unit represents a Tobacco Plains Phase, K'tunaxa/Kutenai occupation. A projectile point found on the surface of the south side of the site (1045/S/Surface/2) resembles the Tobacco Plains projectile style that Reeves distinguishes from Plains Side Notched as having notches higher up the lateral edges of the point form in contrast to Plains Side Notched, which are placed closer to the base. Furthermore, the basal edges flare somewhat which tend to be more common in Tobacco Plains Phase assemblages. This point is also made of TOW chert.

The radiocarbon date from the feature in Unit S-5 indicates this occupation took place circa A.D. 1630. At this time, the Kutenai Indians, or K'tunaxa, were well established in the area encompassing the Rainy Creek site. The Akiyinek band (Thigh Bone People) of K'tunaxa occupied the Kootenai River valley from the present day towns of Troy to Jennings, Montana (Schaeffer 1982). The Rainy Creek site is almost in the middle of this territory. The Akiyinek wintered in the Jennings area, which was known as Thigh Bone, and spent the summer near Libby where they gathered with other bands for trading and games. This is probably the closest circumstantial evidence for making a direct historical link between the archaeological record and ethnographically known people. The single glass trade bead recovered at Rainy Creek came from a level above the dated hearth in Unit S-5, indicating the site was occupied into the

Protohistoric Period, likely by the Kutenai Indians. The bead also indicates trade occurred between the Kutenai and tribes from the north and/or west.

Choquette explains changes in local assemblages in terms of prehistoric migrations. According to Choquette (1987:99), a characteristic of the Inissimi Complex (Kavalla phase) is the common use of Kootenay Argillite and net sinkers that are not found earlier, indicating that Inissimi/Kavalla people in the Middle Kootenai area had a riverine focus, originating in the west. "Transportation of quantities of Kootenai Argillite into the Middle Kootenai Valley would have been difficult without the use of boat" (Choquette 1987:99). Choquette argues that fishing was a primary subsistence activity during this time. However, evidence from Rainy Creek does not support this hypothesis. In fact, there is littlie indication in the middle Kootenai region's archaeological record that fish were important in the diet (Taylor 1973; Munsell and Salo 1979; Roll 1982; Thoms and Burtchard 1987). While the relative frequency of Kootenai Argillite does peak in the lower levels of the Rainy Creek site, generally associated with the Kavalla Phase time period, there is very little evidence of any riverine subsistence specialization, particularly in the deeper levels.

Choquette (1987) interprets the shift to TOW chert and use of specific point types during the Late Period as a cultural replacement of the resident archaeological tradition, that he calls the Akiyinek Complex, by the Akanahonek Complex (TOW-heavy Avonlea occupations). The Akiyinek Complex encompasses Roll's Warex and part of Yarnell, and is associated with Avonlea and Tobacco Plains point styles with assemblages dominated by red/yellow dendritic cherts. Akanahonek includes the same basic point types, but is characterized by almost an exclusive use of TOW Chert for points. These two archaeological complexes according to Choquette are associated with the two Middle Kutenai bands of the same names. At the Rainy Creek site, however, this lithic material trend is actually reversed in the uppermost two levels where TOW chert frequency decreases in the final occupations and is replaced primarily by a variety of other cherts.

This contradiction highlights the great difficulty of equating archaeological complexes with ethnic groups, even in the Late Prehistoric Period. A variety of items were traded from one group to the next, making a correlation between a type of material, artifact type or style with an "ethnic" group problematic. Trade networks running through the long, north-south trending valleys of western Montana certainly facilitated the transportation of goods such as glass beads from the north and obsidian from the southeastern corner of Idaho, without need for mass population movement. Prehistory is not "ahistorical"- an eventless, static world of hunter-gatherers who passively followed rules of optimal foraging. However, there is a persistent problem of confusing the morphological characteristics of artifacts with language or ethnic-based populations (artifact tradition versus hereditary tradition). Increasing development of interband exchange networks or trade is a more likely explanation for the distribution of non-local raw lithic materials in the region.

The interpretation of TOW chert presence, or the presence of other materials, as a time marker may be tenuous, let alone as an indicator of ethnic affiliation. TOW chert debitage does have a high frequency in levels of Unit S-5 that were dated to the very late Late Prehistoric Period; however, the relative frequency of TOW chert site-wide peaks in Level 2 at 30% of the debitage and drops significantly in Level 1 to 12%. Obsidian debitage frequency also drops from Level 2 to Level 1, as does quartzite, rhyodacite, and Purcell Argillite. Kootenay Argillite debitage increases slightly in Level 1 from Level 2 (from 1% to 2%), while Swan River Chert increases dramatically from about 8% in Level 2 to over 35% in Level 1, and chert (undistinguished Montana varieties) steadily increases from lower levels to upper levels, peaking in Level 1 at nearly 35%.

What exactly all of this means is difficult to say. Swan River Chert's sharp rise in use in the uppermost level at Rainy Creek appears to agree with Reeve's observation that in northwestern Montana, Avonlea and Old Women's Phase contain the most Swan River Chert (Reeves 2000:634). This material is found in the glaciated plains of southern Alberta, northeast of the project area, although the ancestors of the Kutenai are believed to have come from the northwest (Reeves 2000; Schaeffer 1982). Interestingly, TOW chert and obsidian peak and drop off in relative frequency in the same levels (peak in Level 2, drop in Level 1). The assumption that TOW chert increases due to the introduction of the Kutenai Indians into the area (because the portion of British Columbia where TOW chert originates is in their ancestral territory) does not seem to hold when TOW chert use actually drops in favor of other cherts.

Another weakness in the ethnic-affiliation model is that the same association of lithic material source and ethnicity is not applied to obsidian, which follows the same pattern. Granted, obsidian is found only in minute quantities at the Rainy Creek site and in northwest Montana generally, but groups using one of these materials also had greater access to the other. Rather than population change, a breakdown in the trade networks that supplied the site inhabitants with both TOW chert and obsidian occurred at some point in the Late Period, creating a marked increase in the use of Montana cherts and Swan River chert from the Plains. The strongest overall pattern of lithic preference at Rainy Creek is that chert is found in steadily greater relative frequency from the lower levels to the upper.

Of importance in Roll's LAURD report is an explicit statement that an in situ adaptation may contain projectile point styles known from other geographic areas. Reeves is also a proponent of locally-derived adaptive innovation. Some researchers seek to explain the various archaeological manifestations in the area as a product of Basin, Plains, or Plateau influence.

This derives from the Culture Area concept. The Culture Area concept is based on divisions from an ethnographically derived classification established in the early twentieth century. Projecting these culture area schemes back in time implies that they were the same thousands of years ago as they were during the contact period. Culture areas may have been vastly different in the past. This view is implicit in the assumption that projectile point styles, the presence or absence of ground stone tools, and pottery types as ethnic, and therefore areal affiliations. The alternative to the Culture Area approach is an emphasis placed on understanding the relationship between the population inhabiting an area and its place in the local ecosystem. This approach examines seasonal mobility patterns and smaller subareas.

Overall trends at Rainy Creek are characterized by a few specific patterns. Most artifact types, including debitage and bone, gradually increase in number from the lower excavated levels to the upper levels, generally peaking in Level 2 (10-20cmbs) and dropping off somewhat in Level 1 (0-10cmbs). Chipped disks, an interesting artifact class of their own, are found primarily in the upper three levels, but one was found in Level 4. This may indicate that the site was used with increasing regularity over time with a late decline. This pattern may be consistent with Reeves' assertion that occupancy in the alpine areas of the Rocky Mountains reached an apex during the Kavalla Phase and then declined somewhat after 1600 years ago (Reeves 2000). According to Reeves, the Late Period saw less intensive and more seasonally structured use of the alpine areas of the Rocky Mountains, with a decline in summer use.

Ground stone artifacts, including manuports and notched pebbles, are well distributed throughout the levels. Two artifacts were found in disturbed surface contexts (mano/pestles), two in Level 1 (a mano and a cobble copper), two in Level 3 (the round stone and a ground wedge), one in Level 4 (small pestle), and two from the deep paleosol (grooved maul and mano/pestle) at approximately 124-150cm below surface (dated to approximately 3720 BP). The three notched pebbles, interpreted as net sinkers, were found on the surface or in trench fill.

Inferences of subsistence practices based on the ground stone at Rainy Creek are speculative and ambiguous. Ground stone is often considered evidence for plant-derived food preparation. However, trace residue analysis indicates that ground stone at Rainy Creek was used both on plants and animals. Capparaceae was detected on a mano/pestle from the surface of the site, and Chenopodiacea and rabbit were detected on the same small pestle from Level 4 (40cm below surface). The grooved maul from the deep paleosol tested negative for any trace residue, but could have been used to pound vegetable matter or crack bones. Chances are it was used for both.

The assemblages from the Late Period Phases at Rainy Creek do not appear to be any less "archaic" than the Middle Period (Plains Archaic Period) assemblages in the sense of "archaic" as a relatively generalized, broad-spectrum subsistence strategy. Although deer may have been the preferred prey species in the area based on the LAURD Project data, the lifestyle of the peoples who inhabited the Rainy Creek site cannot be characterized as a specialized deer-hunting adaptation, nor could they be described as truly riverine adapted in an economic sense of "fisher-folk". As stated above, the middle Kootenai valley area during prehistory could be characterized by a lack of the kind of high bulk food resources that human populations in neighboring areas keyed on: bison to the east, camas and salmon to the west and south, and caribou to the north. However, the absence of yearly focus on a particular resource likely created an adaptation that was perhaps more stable in the long run for those who resided in the middle Kootenai region.

Questions of seasonality of site use at Rainy Creek are difficult to address in the absence of formal faunal analysis. However, models of alpine seasonal "transhumance" typically predict foragers moving up through montane ecotones hunting and gathering resources in a seasonally timed pattern. This "elevationally regulated" seasonal movement allows hunter-gatherers to maintain proximity to their food sources. This model usually describes populations aggregating at preferred campsites in lower elevations during the winter. The Rainy Creek site location appears to provide access to a variety of animal, plant, and aquatic resources. This productive patch on the landscape may have allowed relatively extended stays at Rainy Creek, making it ideally suited for winter residential base camps. There is no question that groups of people returned to Rainy Creek for centuries.

Most archaeologists now agree that the Northern Rocky Mountains are not marginal to the Plains and Plateau, but are a core area that has been continuously occupied throughout prehistory. A variety of food resources were always available in the mountains, and their availability and production were likely less subject to even short-term climatic oscillation, as was the case in some adjacent areas (e.g. the drop in bison populations and other resources on the Plains during the Altithermal drought). The Rainy Creek site excavation has contributed to the on-going refinement of understanding prehistoric lifeways and adaptations of the indigenous inhabitants of the middle Kootenai valley.

In summary, the material culture record of 24LN1045 documents occupation of the locality at least to about 3720 years ago. The site was repeatedly occupied during this period and occupation continued up to historic times, with K'tunaxa/Kutenai Indians unquestionably among site occupants. Most occupations appear to have been relatively intense and most are characterized by large quantities of "deer-like" bone and heat-altered rock. Preliminary indications from two deeply buried cultural strata, which were not sampled by hand excavation, suggest a similar emphasis on deer procurement and processing. The high frequency of heat-altered rock may be associated with particular deer processing activities. Roasting of meat is indicated by the presence of two cultural features identified as roasting platforms. Highly fractured bone, along with highly fractured heat-altered rock suggests that stone boiling was a common activity and likely included production of bone grease and extraction of marrow. Presence of hunting tools, like projectile points, indicates game procurement was as much a part of site activities as game processing. The high frequencies of disk knives or disk tools, which were strongly associated with areas containing large quantities of butchered bone and heat-altered rock, indicates that these tools were important in some aspect (or aspects) of game processing (e.g. hide scraping, meat cutting and deboning). Although only a single bone tool (an awl) was recovered, it does indicate that hide-working was carried out at the site. Presence of grinding tools, along with plant residues found on several artifacts, suggests that some plant (likely seeds) processing also occurred at the site. In short, at 24LN1045, there appears to have been a focus on deer procurement and processing from about 3700 years ago to the protohistoric era. The extremely fragmentary condition of the bone suggests that these animals were thoroughly and completely utilized with absolutely no wastage.

There has been much speculation that Rainy Creek was the location of one or more historic fur trading posts. Several references place the location of those posts on the south side of Rainy Creek. Although 2000 excavations were limited, excavation units were placed throughout the south portion of the site and a large part of this area was heavy-equipment-stripped and was monitored by ACRCS. Artifacts associated with the fur trade era were not found. The blue glass trade bead found south of Rainy Creek exhibits evidence of having been strung and worn and most likely associates with a historic Kutenai Indian occupation. Trading posts are known to have been the focus of varied activity and if occupied for any length of time have been demonstrated to contain dense and varied historic debris and artifacts. Historic artifacts post-dating 1900 were found during monitoring and they likely associate with the Ben Thomas residence. It therefore seems extremely unlikely that a fur trading post was ever located at Rainy Creek for any length of time. It is possible that evidence of the fur trade era was destroyed by vermiculite processing activities that began in the 1930s. The north side of Rainy

Creek was particularly ravaged by these developments, and the south side did not escape substantial disturbance.

MANAGEMENT SUMMARY AND FUTURE RESEARCH

by
Stephen A. Aaberg

Nine square meters of hand excavation, amounting to 8.7 cubic meters of sampled deposits, were accomplished during the Rainy Creek Site investigations in 2000, as part of the EPA administered Libby Asbestos Removal Project. Investigations were augmented by emplacement of nine backhoe trenches encompassing 545 square meters. Occupations dating from about 2000 years ago and extending to the protohistoric period were documented in the hand-excavated units. Two additional occupations dating to about 2800 years ago and 3700 years ago were identified in two backhoe trenches.

Asbestos remediation included heavy equipment stripping of the entire site area. Depth of stripping varied considerably with some areas stripped to over 10' below surface and other areas stripped to about 18 to 20 inches below surface. While it appears that most of the densely occurring occupational zones have been completely obliterated by asbestos remediation, some cultural deposits remain intact, sealed beneath fill brought in by EPA subcontractors as part of post-remediation reclamation. The two deep culture-bearing strata on the alluvial fan likely survived remediation on the south side of Rainy Creek. These strata are sealed and well separated from other occupations. As such, they represent important cultural deposits that could address many questions on settlement and subsistence during the Middle Prehistoric Period. Other investigators (Roll 1982; Roll and Smith 1982) experienced problems of stratigraphic separation of multiple occupations covering long periods of time. The deep culture-bearing strata at Rainy Creek therefore offer unusual potential for examining discrete cultural occupations.

In 2000, excavation unit S-5 was placed on a remnant of the T1 terrace. It is not known if this remnant survived asbestos remediation. If it did, this area also offers great research potential. Intact and discrete Late Prehistoric Period and Protohistoric occupations were identified in this area. Further excavations in this area could lead to associating particular projectile points, other tools, and particular lithic material types with the K'tunaxa/Kutenai Indians. Their presence is documented by recovery of a blue grass trade bead and exposure of a cultural hearth dated to about 320 years ago.

Finally, it must be mentioned that EPA emergency response projects present certain obstacles to the Section 106 compliance process that must be overcome. Everyone recognizes that human health and safety come first. However, every effort must be made to comply with cultural resource laws and statutes. The Salish-Kootenai THPO expressed their concern over the "fast-tracking" approach to the Libby Asbestos Project and the associated Rainy Creek Site mitigation and data recovery project. The pace of the asbestos remediation project, at times resulted in failures in communication. ACRCS perceives part of this problem as related to the lack of cultural resource specialists on the staff of the EPA. Regional EPA personnel are first and foremost charged with administering the emergency response projects. The scale and complexity of the Libby Asbestos Remediation Project seemed daunting to ACRCS, let alone cultural resource issues. Yet it was our experience that the same EPA officials charged with directing the remediation project were also, by default, responsible for cultural resource compliance. Most federal agencies recognize the effort and complexity of the 106 process and many, such as the U.S. Forest Service, the Bureau of Land Management, and the Bureau of Reclamation, have large staffs of cultural resource specialists. Section 106 compliance issues should not be circumvented simply because an agency does not have the time or staff to deal with them.

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APPENDIX A:

GEOARCHAEOLOGICAL TABLES

Table 1. Occupation churn zone thickness in eolian sand settings and their predicted archaeological implications.

SOIL TEXTURE (dry and relatively unveget-ated)	DEPOSITIONAL, PEDOLOGICAL, AND DIAGENIC ENVIRONMENT	ESTIMATED CHURN ZONE THICKNESS (in cm)	HORIZONTAL SCUFFING	EASE OF OCCUPANT CLEANING	ABILITY TO IDENTIFY ACTIVITIES	ABILITY TO IDENTIFY DOMESTIC AREAS
sand	eolian sand	5-16	low	low	high	low
loamy sand	eolian sands with weak pedologic or diagenic modification	3-8	moderate	moderate	moderate	moderate
sandy loams and finer (also most gravels)	strongly modified eolian sands or other types of deposits	<5	high	high	low	high

Table 2. T4/T3 terrace descriptions, 24LN1045.

SITE: 24LN1045

SECTION: Kootenai River valley

STRATUM NUMBER: T4 and T3 terrace deposits

SEDIMENT CLASSIFICATION:

a. T4/T3 TERRACE DEPOSITS-SMALL BOULDERS TO LARGE COBBLES INTERBEDDED WITH SAND, SILT, AND CLAY, GLACIO-FLUVIO-LACUSTRINE DEPOSITS, LATE PLEISTOCENE

CONTACT TYPE:?

BEDDING: DISTINCT---VAGUE

MOIST COLOR: ?

BEDS:

5m	1m	.1m	1cm	1mm
+	+	+	+	+

LAMINATIONS:

DATABLE MATERIAL:

PRIMARY STRUCTURES:

GRAIN SIZES:

		<	a	>				< a	>	
RANGE:	mm	512	128	32	8	2	.5	.13	.03	.003
		+	+	+	+	+	+	+	+	+
		+	+	+	+	+	+	+	+	
MEDIAN:	mm	256	64	16	4	1	.25	.06	.004	
		a								

SORTING: VERY WELL WELL MODERATE POOR VERY POOR
a (WELL)

ROUNDNESS: VERY ANG. ANG. SUBANG. SUBROU. ROU. WELL ROU.
a (ROU.)

PACKING: LOOSE MODERATE TIGHT PRESSED
?

FABRIC:

DEPOSITIONAL ENVIRONMENT: glacial, fluvial, and lacustrine

PEDOGENIC ALTERATION:

Table 3. Stratum I description, 24LN1045.

SITE: 24LN1045

SECTION: DEEP ALLUVIAL FAN DEPOSITS

STRATUM NUMBER: I

SEDIMENT CLASSIFICATION:

a. STRATUM I-GRAVELLY SILT, ALLUVIAL FAN DEBRIS FLOW DEPOSITS, LATE PLEISTOCENE

CONTACT TYPE: unknown

BEDDING: DISTINCT--------------------------X--------------------------VAGUE

MOIST COLOR: ?

BEDS:

5m 1m .1m 1cm 1mm

+--------+--------+--------+--------+

LAMINATIONS:

DATABLE MATERIAL: ?

PRIMARY STRUCTURES:

GRAIN SIZES:

					<?_____	_____	_____	c_____	_____	>
RANGE:	mm	512	128	32	8	2	.5	.13	.03	.003
MEDIAN:	mm	256	64	16	4	1	.25	.06	.004	

SORTING: VERY WELL WELL MODERATE POOR VERY POOR

?

ROUNDNESS: VERY ANG. ANG. SUBANG. SUBROU. ROU. WELL ROU.

?

PACKING: LOOSE MODERATE TIGHT PRESSED

?

FABRIC:

DEPOSITIONAL ENVIRONMENT: alluvial fan

PEDOGENIC ALTERATION:

Table 4. Stratum II description, 24LN1045.
SITE: 24LN1045

SECTION: North Area, Deep Trench

STRATUM NUMBER: II

SEDIMENT CLASSIFICATION:

a. STRATUM IIa-NONPARALLEL BEDDED, SILTY GRAVEL, LOESS INFLUENCED ALLUVIAL FAN DEBRIS FLOW DEPOSIT, LATEST PLEISTOCENE TO EARLY HOLOCENE

b. STRATUM IIb-VERY DARK GRAYISH BROWN, EVEN TO DISCONTINUOUS, EVEN, NONPARALLEL BEDDED, PEBBLY GRAVEL TO MEDIUM GRAINED SAND, ALLUVIAL FAN CHANNEL MARGIN OR OVERBANK DEPOSIT, LATEST PLEISTOCENE TO EARLY HOLOCENE

c. STRATUM IIc-VERY DARK GRAYISH BROWN, MASSIVE, SANDY COARSE COBBLY GRAVEL, ALLUVIAL FAN CHANNEL DEPOSIT, LATEST PLEISTOCENE TO EARLY HOLOCENE

CONTACT TYPE: unknown

BEDDING: DISTINCT---------------------------X---------------------------VAGUE

MOIST COLOR: (a) ?, (b) 2.5Y3/2, © 2.5Y3/2

BEDS: < b >
<c>
5m 1m .1m 1cm 1mm
+--------+--------+--------+--------+
LAMINATIONS: none

DATABLE MATERIAL: none, but is below 6800 B.P. unit

PRIMARY STRUCTURES: nonparallel bedding in IIa and IIb

GRAIN SIZES: <_____ a _____>
<___ b ___>
<_____ 40-80% _____ | ___ c ___>

RANGE:	mm	512		128		32		8		2		.5		.13		.03		.003
		+		+		+		+		+		+		+		+		+
			+		+		+		+		+		+		+		+	
	mm		256		64		16		4		1		.25		.06		.004	
MEDIAN:						a,c							b					

SORTING: VERY WELL WELL MODERATE POOR VERY POOR
b a,c

ROUNDNESS: VERY ANG. ANG. SUBANG. SUBROU. ROU. WELL ROU.
b a,c

PACKING: LOOSE MODERATE TIGHT PRESSED
b,c

FABRIC: none observed
DEPOSITIONAL ENVIRONMENT: alluvial fan
PEDOGENIC ALTERATION: Stage II calcium carbonate occurs on the bottoms of rocks

Table 5. Stratum III description, 24LN1045.

SITE: 24LN1045

SECTION: North Area, Deep Trench

STRATUM NUMBER: III

SEDIMENT CLASSIFICATION:

a. STRATUM III - BROWN, MASSIVE, SLIGHTLY PEBBLY SANDY SILT, VOLCANIC ASH-RICH ALLUVIAL FAN DEPOSIT, MIDDLE HOLOCENE (~6845 ± 50 B.P.)

CONTACT TYPE: sharp

BEDDING: DISTINCT——————————————————X–VAGUE none

MOIST COLOR: 10YR5/3

BEDS: none

```
  5m     1m    .1m    1cm    1mm
  +------+------+------+------+
        LAMINATIONS: none
```

DATABLE MATERIAL: volcanic ash from Mount Mazama eruption at 6845 ± 50 B.P.

PRIMARY STRUCTURES: massive

GRAIN SIZES:

```
                       <____5%______|_________a_______>
         mm   512    128    32     8      2      .5     .13    .03    .003
RANGE:         +      +      +      +      +      +      +      +      +
                  +      +      +      +      +      +      +      +
         mm      256     64     16     4      1     .25    .06    .004
MEDIAN:                                                     a
```

SORTING: VERY WELL WELL MODERATE POOR VERY POOR
a (POOR)

ROUNDNESS: VERY ANG. ANG. SUBANG. SUBROU. ROU. WELL ROU.
?

PACKING: LOOSE MODERATE TIGHT PRESSED
a (MODERATE)

FABRIC: none

DEPOSITIONAL ENVIRONMENT: alluvial fan processes have reworked volcanic ash

PEDOGENIC ALTERATION: slightly oxidized

Table 6. Stratum IV description, 24LN1045.

SITE: 24LN1045

SECTION: North Area, Deep Trench

STRATUM NUMBER: IV

SEDIMENT CLASSIFICATION:

a. STRATUM IVa-VERY DARK GRAYISH BROWN TO DARK GRAYISH BROWN TO YELLOWISH BROWN, SINGLE GRAINED TO WEAKLY BEDDED, SLIGHTLY GRAVELLY TO GRAVELLY COARSE GRAINED SAND, ALLUVIAL FAN CHANNEL DEPOSIT, MIDDLE TO LATE HOLOCENE

b. STRATUM IVb-VERY DARK GRAYISH BROWN TO DARK GRAYISH BROWN, MASSIVE, SLIGHTLY GRAVELLY TO GRAVELLY SILTY SAND, ALLUVIAL FAN SHEET WASH AND DEBRIS FLOW DEPOSIT, MIDDLE TO LATE HOLOCENE

c. STRATUM IVc-VERY DARK GRAYISH BROWN TO DARK GRAYISH BROWN TO BROWN, MASSIVE, GRAVELLY SANDY SILT, LOESS INFLUENCED ALLUVIAL FAN DEPOSIT, MIDDLE TO LATE HOLOCENE

CONTACT TYPE: sharp to stratum III

BEDDING: DISTINCT------------------------------------X------------------VAGUE

MOIST COLOR: (a) 10YR3.5/2 to 10YR5/4, (b) 10YR3.5/2, © 10YR3.5/2 to 10YR5/3

BEDS: <a>

5m 1m .1m 1cm 1mm

+---------+---------+---------+---------+

LAMINATIONS: none

DATABLE MATERIAL: Feature 1 in Test Unit S-5 (320 ± 60 B.P.) in IVc; cultural material in IVb and IVc; organic paleosols in IVa (2860 ± 60 B.P.) and IVb (3720 ± 50 B.P.)

PRIMARY STRUCTURES: a is weakly bedded, b and c are massive

GRAIN SIZES:

< 5-10% | a >

< 40-80% | b >

< 10-30% | c >

mm	512		128		32		8		2		.5		.13		.03		.003	
RANGE:	+		+		+		+		+		+		+		+		+	
		+		+		+		+		+		+		+		+	
mm		256		64		16		4		1		.25		.06		.004	
MEDIAN:								b		a,c							

SORTING: VERY WELL WELL MODERATE POOR VERY POOR

a,c b

ROUNDNESS: VERY ANG. ANG. SUBANG. SUBROU. ROU. WELL ROU.

a,b,c

PACKING: LOOSE MODERATE TIGHT PRESSED

c? a b

FABRIC: (a) weakly clast-supported, (b) matrix-supported, (c)matrix-supported

DEPOSITIONAL ENVIRONMENT: alluvial fan

PEDOGENIC ALTERATION: surface soils

Table 7. Strata descriptions, 24LN1045.
SITE: 24LN1045

SECTION: South Area, Trench 2

STRATUM NUMBER: V

SEDIMENT CLASSIFICATION:

a. STRATUM Va-DARK GRAY, CLAST-SUPPORTED, PEBBLY MEDIUM GRAINED SAND, FLUVIAL OVERBANK DEPOSIT, LATE HOLOCENE

b. STRATUM Vb-GRAYISH BROWN, MATRIX-SUPPORTED, SLIGHTLY PEBBLY FINE GRAINED SAND, FLUVIAL OVERBANK DEPOSIT, LATE HOLOCENE

c. STRATUM Vc-DARK GRAYISH BROWN TO GRAYISH BROWN, SINGLE GRAINED, FINE TO VERY FINE GRAINED SAND, FLUVIAL OVERBANK DEPOSIT, MIDDLE TO LATE HOLOCENE

d. STRATUM Vd-GRAYISH BROWN, MASSIVE, SANDY SILT, FLUVIAL OVERBANK DEPOSIT, LATE HOLOCENE

CONTACT TYPE: sharp

BEDDING: DISTINCT--------X--VAGUE

MOIST COLOR: (a) 10YR4/1, (b) 10YR5/2, © 10YR4.5/2, (d) 10YR5/2

BEDS: <a-d>

5m 1m .1m 1cm 1mm

+--------+--------+--------+--------+

LAMINATIONS: none

DATABLE MATERIAL: archaeological material at upper contact

PRIMARY STRUCTURES: single grained (a-c) to massive (d)

GRAIN SIZES:

< 30-50% | a >

< 2-5% | b >

< c >

< d >

mm	512		128		32		8		2		.5		.13		.03		.003	
RANGE:	+		+		+		+		+		+		+		+		+	
		+		+		+		+		+		+		+		+	
mm		256		64		16		4		1		.25		.06		.004	
MEDIAN:												a b		c d			

SORTING: VERY WELL WELL MODERATE POOR VERY POOR

c d b a

ROUNDNESS: VERY ANG. ANG. SUBANG. SUBROU. ROU. WELL ROU.

b-d? a

PACKING: LOOSE MODERATE TIGHT PRESSED

a-c d

FABRIC: (a) clast supported; (b) matrix-supported

DEPOSITIONAL ENVIRONMENT: fluvial overbank; fining upward sequence

PEDOGENIC ALTERATION: Intermittent gleying. B horizon has medium to coarse angular blocky structure.

Table 8. Summary of strata characteristics for site 24LN1045.

STRATUM #	COLOR	STRUCTURE & FABRIC	PEDOGENIC MODIFICATIONS	GRAIN SIZE	DEPOSITIONAL ENVIRONMENT	CULTURAL MATERIAL	PROBABLE AGE
T4/T3	———	———	———	SMALL BOULDERS TO LARGE COBBLES W/ INTERBEDDED SAND, SILT, & CLAY	GLACIO-FLUVIO-LACUSTRINE	———	LATE PLEISTOCENE
STRATUM I	———	———	———	?GRAVELLY SILT	ALLUVIAL FAN (DEBRIS FLOW)	———	LATE PLEISTOCENE
STRATUM IIa	———	NONPARALLEL BEDDED	SOME STAGE II $CaCO_3$	SILTY GRAVEL	ALLUVIAL FAN (LOESS INFLUENCED)	NONE OBSERVED	LATEST PLEISTOCENE TO EARLY HOLOCENE
STRATUM IIb	VERY DARK (DK) GRAYISH BROWN (BRN)	DISCONTINUOUS, EVEN, TO EVEN, NONPARALLEL BEDDED	SOME STAGE II $CaCO_3$	PEBBLY GRAVEL TO MEDIUM GRAINED SAND	ALLUVIAL FAN (CHANNEL MARGIN OR OVERBANK)	NONE OBSERVED	LATEST PLEISTOCENE TO EARLY HOLOCENE
STRATUM IIc	VERY DK GRAYISH BRN	MASSIVE	SOME STAGE II $CaCO_3$	SANDY COARSE COBBLY GRAVEL	ALLUVIAL FAN CHANNEL	NONE OBSERVED	LATEST PLEISTOCENE TO EARLY HOLOCENE
STRATUM III	BRN	MASSIVE	SLIGHTLY OXIDIZED	SLIGHTLY PEBBLY SANDY SILT	ALLUVIAL FAN	NONE OBSERVED (ASH FROM MOUNT MAZAMA ERUPTION)	(6845 +/- 50 BP) MIDDLE HOLOCENE
STRATUM IVa	VERY DK GRAYISH BRN-DK GRAYISH BRN-YELLOWISH BRN	SINGLE GRAINED TO WEAKLY BEDDED; WEAKLY CLAST-SUPPORTED	OXIDIZED TO NONOXIDIZED	SLIGHTLY GRAVELLY TO GRAVELLY COARSE GRAINED SAND	ALLUVIAL FAN CHANNEL	NONE OBSERVED; ORGANIC PALEOSOL = 2860±60 BP	MIDDLE TO LATE HOLOCENE
STRATUM IVb	VERY DK GRAYISH BRN-DK GRAYISH BRN	MASSIVE; MATRIX-SUPPORTED	$CaCO_3$	SLIGHTLY GRAVELLY TO GRAVELLY SILTY SAND	ALLUVIAL FAN (SHEET WASH AND DEBRIS FLOW)	YES; FEATURE IN TR 3-8 = 1810±50 BP; ORGANIC PALEOSOL = 3720±50 BP	MIDDLE TO LATE HOLOCENE
STRATUM IVc	VERY DK GRAYISH BRN-DK GRAYISH BRN-BRN	MASSIVE; MATRIX-SUPPORTED	SURFACE SOIL WITH Bw HORIZON	GRAVELLY SANDY SILT	ALLUVIAL FAN (LOESS INFLUENCED)	YES; ALSO FEATURE 1 IN TEST UNIT S-5 = 320±60 BP	MIDDLE TO LATE HOLOCENE
STRATUM Va	DK GRAY	CLAST-SUPPORTED	INTERMITTENT GLEYING; $CaCO_3$	PEBBLY MEDIUM GRAINED SAND	FLUVIAL OVERBANK	NONE OBSERVED	LATE HOLOCENE
STRATUM Vb	GRAYISH BRN	MATRIX-SUPPORTED	INTERMITTENT GLEYING	SLIGHTLY PEBBLY FINE GRAINED SAND	FLUVIAL OVERBANK	NONE OBSERVED	LATE HOLOCENE
STRATUM Vc	DK GRAYISH BRN-GRAYISH BRN	SINGLE GRAINED	INTERMITTENT GLEYING	FINE TO VERY FINE GRAINED SAND	FLUVIAL OVERBANK	YES	LATE HOLOCENE
STRATUM Vd	GRAYISH BRN	MASSIVE	INTERMITTENT GLEYING Bw HORIZONS	SANDY SILT	FLUVIAL OVERBANK	YES	LATE HOLOCENE

Table 9. Horizon profile, 24LN1045, North Area

Site: 24LN1045 Location: Deep Trench, North Area Moisture Regime: xeric Temperature Regime: thermic Classification: Xeriorthent

		COLOR			STRUC-	CONSISTENCE			REACT-		BOUND-			SIZE %>	
HORIZON	DEPTH	DRY	MOIST	TEXTURE	TURE	DRY	MOIST	WET	ION	CLAY FILMS	ARY	CaCo3	SALTS	2.0 mm	S#
A*	13	10YR3.5/2	10YR2/1	gls	m	so	vfr	so	none	none	c,w	none	none	30	IVc
C1**	30	10YR6/2	10YR3/2	vgls	none	so	vfr	so	none	none	d,s	none	none	40	IVc
C2	50	10YR6/2	10YR3/2	vgls	none	so	vfr	so	none	none	d,s	none	none	50	IVc
C3	80	10YR6/2	10YR3/2	vgls	none	so	vfr	so	none	none	d,s	none	none	75	IVc

*Contains some vermiculite
**FCR at 16 cmbs

DEFINITIONS

HORIZON:
SCS designation
(modified by Birkeland)
DEPTH:
Lower boundary in cm
COLOR:
Munsell: Dry and Moist
TEXTURE:
Prefixes
cob-cobbly
g-gravelly
Modifiers(sand size)
vco-very coarse
co-coarse
f-fine
vf-very fine
Stems
s-sand
ls-loamy sand
sl-sandy loam
l-loam
si-silt
sil-silt loam
scl-sandy clay loam
cl-clay loam
sicl-silty clay loam
sc-sandy clay
sic-silty clay
c-clay

STRUCTURE:
Grade
m-massive
sg-single grain
1-weak
2-moderate
3-strong
Size
vf-very fine
f-fine
m-medium
c-coarse
vc-very coarse
Type
gr-granular
cr-crumb
pl-platey
pr-prismatic
cpr-columnar
abk-angular blocky
sbk-subangular blocky
REACTION:
el-very slightly effervescent
e-slightly effervescent
es-strongly effervescent
ev-violently effervescent

CONSISTENCE:
Dry
lo-loose, noncoherent
so-weakly coherent
sh-slightly hard
h-hard
vh-very hard
eh-extremely hard
Moist
loose, noncoherent
vfr-very friable
fr-friable
fi-firm
vfi-very firm
fi-extremely firm
br-very firm and brittle
Wet
so-nonsticky
ss-slightly sticky
s-sticky
vs-very sticky

BOUNDARY:
Distinctness
a-abrupt
c-clear
g-gradual
d-diffuse
Topography
s-smooth
w-wavy
i-irregular
b-broken
CLAY FILMS:
Frequency
v1-very few
1-few
2-common
3-many
4-continuous
Thickness
n-thin
mk-moderately thick
k-thick
Morphology
pf-ped faces
po-pores
br-bridges
co-coatings on grain

CARBONATES AND SALTS:
Size
0-very thin
1-fine
2-medium
3-large
Shape
r-generally rounded
i-irregularly shaped
Abundance
f-few
c-common
m-many
Distribution
d-disseminated
su-segregated
sf-filaments or threads
ss-seams
m-soft masses
sc-concretions
sb-bottoms of rocks
S#:
Stratum Number

Table 10. Horizon profile, 24LN1045, South Area.

Site: 24LN1045 Location: Trench 1, South Area Moisture Regime: xeric Temperature Regime: thermic Classification: Xeriorthent

HORIZON	DEPTH	COLOR DRY	COLOR MOIST	TEXTURE	STRUCTURE	CONSISTENCE DRY	CONSISTENCE MOIST	CONSISTENCE WET	REACTION	CLAY FILMS	BOUNDARY	CaCo3	SALTS	SIZE %> 2.0 mm	S#
Ap	~5	10YR6/2	10YR3.5/2	sl	2,f,pl	so	vfr	ss	e	none	c,w	none	none	1	Vd
Bw1	9	10YR6/2	10YR3.5/2	sl	2,m,sbk	so	vfr	ss	e	none	c,w	none	none	0	Vd
Bw2	19	10YR7/2	10YR4/2	lvfs	2,c,sbk	so	vfr	ss	e	none	g,w	none	none	0	Vd
Bw3	32	10YR7/2	10YR4/2	vfs	2,vc,sbk	so	vfr	so	es	none	d,w	none	none	0	Vd
C1	55	10YR7/2	10YR4/2	fs	sg	lo	lo	so	es	none	g,s	none	none	0	Vc
C2	90	10YR5/2	10YR4/2	fs	sg	lo	lo	so	es	none	g,s	none	none	0	Vc
C3	100	10YR5/2	10YR4/2	ms	sg	lo	lo	so	es	none	a,s	none	none	2	Vb
C4	120	10YR4.5/2	10YR4/2	gms	sg	lo	lo	so	es	none	?	O,c,sb	none	30	Vs

DEFINITIONS

HORIZON:
SCS designation
(modified by Birkeland)
DEPTH:
Lower boundary in cm
COLOR:
Munsell: Dry and Moist
TEXTURE:
Prefixes
cob-cobbly
g-gravelly
Modifiers(sand size)
vco-very coarse
co-coarse
f-fine
vf-very fine
Stems
s-sand
ls-loamy sand
sl-sandy loam
l-loam
si-silt
sil-silt loam
scl-sandy clay loam
cl-clay loam
sicl-silty clay loam
sc-sandy clay
sic-silty clay
c-clay

STRUCTURE:
Grade
m-massive
sg-single grain
1-weak
2-moderate
3-strong
Size
vf-very fine
f-fine
m-medium
c-coarse
vc-very coarse
Type
gr-granular
cr-crumb
pl-platey
pr-prismatic
cpr-columnar
abk-angular blocky
sbk-subangular blocky
REACTION:
et-very slightly effervescent
e-slightly effervescent
es-strongly effervescent
ev-violently effervescent

CONSISTENCE:
Dry
lo-loose, noncoherent
so-weakly coherent
sh-slightly hard
h-hard
vh-very hard
eh-extremely hard
Moist
loose, noncoherent
vfr-very friable
fr-friable
fi-firm
vfi-very firm
fi-extremely firm
br-very firm and brittle
Wet
so-nonsticky
ss-slightly sticky
s-sticky
vs-very sticky

BOUNDARY:
Distinctness
a-abrupt
c-clear
g-gradual
d-diffuse
Topography
s-smooth
w-wavy
i-irregular
b-broken
CLAY FILMS:
Frequency
v1-very few
1-few
2-common
3-many
4-continuous
Thickness
n-thin
mk-moderately thick
k-thick
Morphology
pf-ped faces
po-pores
br-bridges
co-coatings on grain

CARBONATES AND SALTS:
Size
0-very thin
1-fine
2-medium
3-large
Shape
r-generally rounded
i-irregularly shaped
Abundance
f-few
c-common
m-many
Distribution
d-disseminated
su-segregated
sf-filaments or threads
ss-seams
m-soft masses
sc-concretions
sb-bottoms of rocks
S#:
Stratum Number

Table 11. Horizon profile, 24LN1045, South Area.

Site: 24LN1045 Location: TU S-1 & Trench 3, South Area Moisture Regime: xeric Temperature Regime: thermic Classification: Xeriorthent

HORIZON	DEPTH	COLOR DRY	COLOR MOIST	TEXTURE	STRUCTURE	CONSISTENCE DRY	CONSISTENCE MOIST	CONSISTENCE WET	REACTION	CLAY FILMS	BOUNDARY	CaCo3	SALTS	SIZE %> 2.0 mm	S#
A	7	—	10YR3.5/2	gsl	sg	sh	–	ss	sl	none	c,b	none	none	10	IVc
AB	20	—	10YR3.5/2	gsl	sg	sh	–	ss	sl	none	c,s	none	none	30	IVc
Bw	70	—	10YR3.5/2	gsl	1,m,sbk	lo	–	so	ev	none	a,w	none	none	15	IVc
Ck	90	—	10YR5/2	gsl	sg	–	–	–	ev	none	?	none	none	4	IVb

DEFINITIONS

HORIZON:
SCS designation
(modified by Birkeland)
DEPTH:
Lower boundary in cm
COLOR:
Munsell: Dry and Moist
TEXTURE:
Prefixes
cob-cobbly
g-gravelly
Modifiers(sand size)
vco-very coarse
co-coarse
f-fine
vf-very fine
Stems
s-sand
ls-loamy sand
sl-sandy loam
l-loam
si-silt
sil-silt loam
scl-sandy clay loam
cl-clay loam
sicl-silty clay loam
sc-sandy clay
sic-silty clay
c-clay

STRUCTURE:
Grade
m-massive
sg-single grain
1-weak
2-moderate
3-strong
Size
vf-very fine
f-fine
m-medium
c-coarse
vc-very coarse
Type
gr-granular
cr-crumb
pl-platey
pr-prismatic
cpr-columnar
abk-angular blocky
sbk-subangular blocky
REACTION:
sl-very slightly effervescent
e-slightly effervescent
es-strongly effervescent
ev-violently effervescent

CONSISTENCE:
Dry
lo-loose, noncoherent
so-weakly coherent
sh-slightly hard
h-hard
vh-very hard
eh-extremely hard
Moist
loose, noncoherent
vfr-very friable
fr-friable
fi-firm
vfi-very firm
fi-extremely firm
br-very firm and brittle
Wet
so-nonsticky
ss-slightly sticky
s-sticky
vs-very sticky

BOUNDARY:
Distinctness
a-abrupt
c-clear
g-gradual
d-diffuse
Topography
s-smooth
w-wavy
i-irregular
b-broken
CLAY FILMS:
Frequency
v1-very few
1-few
2-common
3-many
4-continuous
Thickness
n-thin
mk-moderately thick
k-thick
Morphology
pf-ped faces
po-pores
br-bridges
co-coatings on grain

CARBONATES AND SALTS:
Size
0-very thin
1-fine
2-medium
3-large
Shape
r-generally rounded
i-irregularly shaped
Abundance
f-few
c-common
m-many
Distribution
d-disseminated
su-segregated
sf-filaments or threads
se-seams
m-soft masses
sc-concretions
sb-bottoms of rocks
S#:
Stratum Number

Table 12. Characteristics of Kootenai National Forest, vegetation response units (VRU's). Data from U. S. Forest Service, Kootenai National Forest (1999).

KNF VRU #	THIS REPORT VRU's	HABITAT SETTING	ELEVA-TION RANGE	LANDFORM	PRECIPI-TATION (PPT)	PERCENT PPT AS RAIN	PRINCIPAL VEGETATION	WINTER RANGE	SUMMER RANGE
NONE	A	warm and extremely dry	est. 2000-4000"	est. lower mountain slopes and valley bottoms	est. 8-10"	not specified	antelope bitterbrush, rough fescue, arrowleaf balsamroot	[1] primary with few trees	secondary
NONE	B	warm and very dry	est. 2000-4000"	est. lower mountain slopes and valley bottoms	est. 10-14"	not specified	rough fescue, western wheatgrass, Idaho fescue, ponderosa pine, arrowleaf balsamroot, lomatium	[1] primary mostly openings	secondary
1	C	warm and dry	2000-5400'	mountain slopes & valleys or steep west and southerly aspects	14-25"	>50%	ponderosa pine, western larch, Douglas fir	[1] primary with many openings	secondary
2	D	moderately warm and dry	2000-5800	lower elevation ridges to uplands to upper elevation draws	16-30"	75%	ponderosa pine / Douglas fir dry at lower elevations western larch / lodgepole pine with ponderosa pine moist upland	[1] primary with some openings	secondary
3	E	moderately warm and moderately dry	2000-5800	transitional from VRU's 1 & 2 to 5	18-30" (70%) rain	70%	Douglas fir, western larch, ponderosa pine dry lower elev. Douglas fir, western larch, lodgepole pine moist uplands	secondary	primary
4	F	moderately warm and moist	2000-6400	lower slopes and valley bottoms	30+"	not specified	western larch, Douglas fir with lodgepole pine, grand fir, whitebark pine, ponderosa pine	secondary	primary
5	G	moderately cool and moist	1800-6400	benches and stream bottoms	30-50"	not specified	western larch / Douglas fir with whitebark pine, Engelmann spruce, lodgepole pine, grand fir, western redcedar, western hemlock	secondary	primary

KNF VRU #	THIS REPORT VRU's	HABITAT SETTING	ELEVA-TION RANGE	LANDFORM	PRECIPI-TATION (PPT)	PERCENT PPT AS RAIN	PRINCIPAL VEGETATION	WINTER RANGE	SUMMER RANGE
6	H	moderately cool and wet	2200-5500	stream-sides and wetlands	30-55"	60%	western redcedar, western hemlock, whitebark pine, western larch, Engelmann spruce, *Devil's club, lady fern, subalpine fir*	primary at lower elevations	primary at higher elevations
7	I	cool and moist	2000-7000	lower subalpine slopes, northwest to east facing slopes, riparian and poorly drained alpine sites, and moist frost pockets	35-55"	<50%	western larch, lodgepole pine, whitebark pine, Engelmann spruce, Douglas fir with grand fir, subalpine fir, *western redcedar, western hemlock*	secondary	primary
8	J	cool and wet	3200-5600	stream-sides and wetlands	30-55"	40%	western redcedar, western hemlock, whitebark pine, western larch, Engelmann spruce	primary at lower elevations	primary at higher elevations
9	K	cool and moderately dry	>5400	rolling ridges and upper reaches of convex mountain slopes	35-70"	minority	Lodgepole pine, subalpine fir in frost pockets, Engelmann spruce, Douglas fir, western larch on moist upland sites	none	primary
10	L	cold and moderately dry	4500-7800	upper reaches of fairly steep, convex mountain slopes	50-80"	minority	whitebark pine, Engelmann spruce, lodgepole pine with subalpine fir, mountain hemlock	none	primary
11	M	cold	5300-8600	steep alpine ridges and cirque headwalls	60-90"	minority	alpine larch, whitebark pine, Engelmann spruce, subalpine fir	none	primary

1 whitetail deer avoid openings when snow depth is >18"

Table 13. Predicted substitutions in vegetation response units (VRU's) given various scenarios of climatic change. See Figures 32, 33, and 34 for timing of more, less, and much less snow accumulation.

KOOTENAI NATIONAL FOREST VRU#	THIS REPORT VRU'S	PRESENT DAY SNOWFALL ACCUMULATION PERIOD AND VRU'S FOR THIS REPORT	MODELED LESS SNOWFALL ACCUMULATION PERIOD AND VRU'S FOR THIS REPORT	MODELED *MUCH* LESS SNOWFALL ACCUMULATION PERIOD AND VRU'S FOR THIS REPORT	MODELED GREATER SNOWFALL ACCUMULATION PERIOD AND VRU'S FOR THIS REPORT
1	C	C	B	A	D
2	D	D	C	B	E
3	E	E	D	C	F
4	F	F	E	D	G
5	G	G	F	E	H
6	H	H	G	F	I
7	I	I	H	G	J
8	J	J	I	H	K
9	K	K	J	I	L
10	L	L	K	J	M
11	M	M	L	K	N = BARREN, SNOW, ICE

APPENDIX B:

CHIPPED STONE ATTRIBUTE TABLES

Table 1. Debitage and debris attributes recording form from 24LN1045.

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
N-1	1 (0-10cm bs)			Quartzite	Grey	G1	SDC	BF	+	1
N-1	1 (0-10cm bs)			Quartzite	Grey	G2	SDC	BF	+	1
N-1	1 (0-10cm bs)			Obsidian	Translucent Black	G3	PF	BF	-	1
N-1	1 (0-10cm bs)			Chert	Reddish Tan	G3	BTF	BF	-	1
N-1	1 (0-10cm bs)			Chert	Translucent White	G3	PF	CF	-	1
N-1	1 (0-10cm bs)			Chert	Light Grey	G3	PF	CF	-	1
N-1	1 (0-10cm bs)			Chert	Tannish Grey	G3	IPF	FF	-	1
N-1	1 (0-10cm bs)			Quartzite	Light Grey	G3	PF	FF	-	1
N-1	1 (0-10cm bs)			Basalt	Dull Black	G3	PF	CF	-	2
N-1	1 (0-10cm bs)			Quartzite	White	G4	SH	SH	-	1
N-1	1 (0-10cm bs)			Chert	Dark Red	G4	PF	CF (3), BF (1)	-	4
N-1	1 (0-10cm bs)			Chert	Light Grey	G4	PF	CF (2), BF (2)	-	4
N-1	1 (0-10cm bs)			Basalt	Dull Black	G4	PF	BF (2), FF (1)	-	3
N-1	2 (10-20cm bs)			Quartzite	Tan	G2	PDC	CF	+	1
N-1	2 (10-20cm bs)			Quartzite	Grey	G2	IPF	BF	-	1
N-1	2 (10-20cm bs)			Purcell Argillite	Dark Green	G2	SDC	CF	+	1
N-1	2 (10-20cm bs)			T-O-W Chert	Dark Grey	G3	BTF	CF	-	2
N-1	2 (10-20cm bs)			T-O-W Chert	Dark Grey	G3	SH	SH	+	1
N-1	2 (10-20cm bs)			Quartzite	White	G3	IPF	FF	-	2
N-1	2 (10-20cm bs)			Rhyodacite	Greasy Black	G3	PF	CF (2), BF (1)	-	3
N-1	2 (10-20cm bs)			T-O-W Chert	Light Grey	G3	IPF	BF	-	1
N-1	2 (10-20cm bs)			T-O-W Chert	Light Grey	G3	PF	CF	-	1
N-1	2 (10-20cm bs)			Chert	Tannish-Off White	G3	BTF	FF	-	1
N-1	2 (10-20cm bs)			Chert	Mottled Brown, Black, and Tan	G3	BTF	CF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
N-1	2 (10-20cm bs)			Purcell Argillite	Light Green	G3	PF	CF	-	1
N-1	2 (10-20cm bs)			Quartzite	Light Grey	G3	IPF	FF	-	2
N-1	2 (10-20cm bs)			Obsidian	Translucent Black	G4	PF	CF (2), FF (2)	-	4
N-1	2 (10-20cm bs)			Obsidian	Dark Greenish Black	G4	PF	CF	-	1
N-1	2 (10-20cm bs)			Chert	Dark Red	G4	PF	BF	-	1
N-1	2 (10-20cm bs)			Chert	Light Red	G4	PF	CF (4), BF (1)	-	5
N-1	2 (10-20cm bs)			Chert	Pinkish White	G4	PF	CF	-	1
N-1	2 (10-20cm bs)			Chert	Tannish Yellow	G4	PF	CF	-	1
N-1	2 (10-20cm bs)			Chert	Light Grey	G4	PF	CF	-	1
N-1	2 (10-20cm bs)			Chert	Dark Brown	G4	PF	CF (1), BF (1)	-	2
N-1	2 (10-20cm bs)			Quartzite	Yellowish White	G4	SH	SH	-	1
N-1	2 (10-20cm bs)			Quartzite	Greyish White	G4	PF	FF	-	3
N-1	2 (10-20cm bs)			Basalt	Dull Black	G4	PF	CF (3), FF (1)	-	4
N-1	3 (20-30cm bs)			T-O-W Chert	Light Blue-Grey	G2	IPF	FF	-	1
N-1	3 (20-30cm bs)			Chert	Dark Red	G3	PF	CF	-	1
N-1	3 (20-30cm bs)			Quartzite	White	G4	SH	SH	-	1
N-1	3 (20-30cm bs)			Quartzite	White	G4	IPF	FF	-	1
N-1	3 (20-30cm bs)			Quartzite	Dark Grey	G4	IPF	FF	-	2
N-1	3 (20-30cm bs)			Quartzite	Mottled Light Grey and Black	G4	PF	BF	-	1
N-1	3 (20-30cm bs)			Chert	Off-White	G4	PF	CF	-	1
N-1	3 (20-30cm bs)			Basalt	Dull Black	G4	PF	CF (3), BF (1)	-	4
N-2	1 (0-10cm bs)			T-O-W Chert	Light Grey	G2	IPF	BF	-	1
N-2	1 (0-10cm bs)			T-O-W Chert	Light Grey	G3	IPF	FF	-	1
N-2	1 (0-10cm bs)			T-O-W Chert	Light Grey	G3	BTF	CF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
N-2	1 (0-10cm bs)			T-O-W Chert	Greenish Grey	G3	BTF	BF	-	2
N-2	1 (0-10cm bs)			Kootenai Argillite	Light Green w/ white crescents	G3	BTF	BF	-	1
N-2	1 (0-10cm bs)			Kootenai Argillite	Light Green w/white crescents	G3	PF	CF	-	1
N-2	1 (0-10cm bs)			Quartzite	White	G3	IPF	BF	-	1
N-2	1 (0-10cm bs)			Quartzite	Grey	G3	IPF	BF(2), FF (1)	-	3
N-2	1 (0-10cm bs)			Obsidian	Opaque Black	G4	PF	FF	-	1
N-2	1 (0-10cm bs)			Basalt	Dull Black	G4	PF	CF	-	1
N-2	1 (0-10cm bs)			Chert	Black	G4	PF	CF	-	2
N-2	1 (0-10cm bs)			Chert	White	G4	PF	FF	-	2
N-2	1 (0-10cm bs)			Chert	Brownish Red	G4	PF	CF	-	2
N-2	1 (0-10cm bs)			Chert	Yellowish Tan	G4	SH	SH	-	1
N-2	1 (0-10cm bs)			Chert	Brown w/intrusions	G4	PF	CF	-	1
N-2	1 (0-10cm bs)			T-O-W Chert	Light Greenish Grey	G4	PF	FF	-	4
N-2	1 (0-10cm bs)			Purcell Argillite	Light Grey	G4	SH	SH	-	2
N-2	2 (10-20cm bs)			Obsidian	Translucent Black	G3	BTF	FF	-	1
N-2	2 (10-20cm bs)			Quartzite	White	G3	IPF	BF	-	1
N-2	2 (10-20cm bs)			Quartzite	White	G3	SH	SH	-	1
N-2	2 (10-20cm bs)			Quartzite	Grey	G3	IPF	BF	-	1
N-2	2 (10-20cm bs)			Obsidian	Translucent Black	G4	PF	BF	-	1
N-2	2 (10-20cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF	-	1
N-2	2 (10-20cm bs)			Chert	Brownish Red	G4	PF	CF	-	1
N-2	2 (10-20cm bs)			Quartzite	Greyish White	G4	PF	BF	-	1
N-2	3 (20-30cm bs)			T-O-W Chert	Light Grey	G3	PF	BF	-	1
N-2	3 (20-30cm bs)			Quartzite	White	G3	IPF	FF	-	2

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
N-2	3 (20-30cm bs)			Quartzite	Light Grey	G3	PF	BF	-	1
N-2	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G4	PF	BF	-	1
N-2	7 (60-70cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	IPF	FF	-	1
N-2	7 (60-70cm bs)			T-O-W Chert	Light Grey	G4	PF	CF	-	1
S-1	1 (0-10cm bs)			Basalt	Dull Black	G2	BTF	BF	-	2
S-1	1 (0-10cm bs)			T-O-W Chert	Dark Grey	G3	PF	BF	-	2
S-1	1 (0-10cm bs)			Chert (Swan River)	Glassy White	G3	PF	CF	-	1
S-1	1 (0-10cm bs)			Chert	Mottled brown, black and white	G3	PF	CF (1), BF (2)	-	3
S-1	1 (0-10cm bs)			Purcell Argillite	Light Green	G3	IPF	BF	-	1
S-1	1 (0-10cm bs)			Purcell Argillite	Light Green	G3	PF	BF	-	2
S-1	1 (0-10cm bs)			Chert	Brownish Red	G4	PF	CF	-	1
S-1	1 (0-10cm bs)			T-O-W Chert	Dark Grey	G4	PF	CF	-	1
S-1	1 (0-10cm bs)			T-O-W Chert	Light Grey	G4	PF	BF	-	2
S-1	1 (0-10cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF	-	1
S-1	1 (0-10cm bs)			Chert (Swan River)	Translucent Glassy White	G4	PF	CF	-	1
S-1	1 (0-10cm bs)			T-O-W Chert	Dark Grey	G5	PF	CF	-	1
S-1	2 (10-20cm bs)			Rhyodacite	Greasy Black	G2	IPF	FF	-	1
S-1	2 (10-20cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	PF	BF	-	1
S-1	2 (10-20cm bs)			Quartzite	Dark Grey-Black	G3	BTF	CF	-	1
S-1	2 (10-20cm bs)			Rhyodacite	Greasy Black	G3	OF	CF	-	1
S-1	2 (10-20cm bs)			T-O-W Chert	Dark Grey	G3	PF	CF	-	2
S-1	2 (10-20cm bs)			Chert	Brownish Red	G3	BTF	BF	-	1
S-1	2 (10-20cm bs)			Purcell Argillite	Light Green	G3	BTF	BF	-	1
S-1	2 (10-20cm bs)			Purcell Argillite	Light Green	G3	PF	CF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-1	2 (10-20cm bs)			Purcell Argillite	Light Green	G4	PF	CF (1), BF (2)	-	3
S-1	3 (20-30cm bs)			Quartzite	Dark Grey	G2	PDC	FF	+	2
S-1	3 (20-30cm bs)			Quartzite	Light Grey	G2	IPF	FF	-	2
S-1	3 (20-30cm bs)			Quartzite	Reddish Grey	G2	IPF	BF	-	1
S-1	3 (20-30cm bs)			Rhyodacite	Greasy Black	G2	PDC	BF	+	1
S-1	3 (20-30cm bs)			T-O-W Chert	Dark Greenish Grey	G2	IPF	CF	-	1
S-1	3 (20-30cm bs)			Purcell Argillite	Light Green	G2	BTF	BF	-	1
S-1	3 (20-30cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	IPF	FF	-	2
S-1	3 (20-30cm bs)			Chert (Swan River)	Glassy White	G3	BTF	BF	-	1
S-1	3 (20-30cm bs)			Chert	Mottled Red, Brown and Black	G3	BTF	FF	-	1
S-1	3 (20-30cm bs)			Chert	Dark Red	G3	PF	CF	-	1
S-1	3 (20-30cm bs)			Rhyodacite	Greasy Black	G3	IPF	FF	-	4
S-1	3 (20-30cm bs)			Rhyodacite	Greasy Black	G3	BTF	CF	-	1
S-1	3 (20-30cm bs)			Quartzite	Greyish White	G3	PF	CF	-	1
S-1	3 (20-30cm bs)			T-O-W Chert	Light Grey	G3	PF	CF	-	1
S-1	3 (20-30cm bs)			Chert (Swan River)	Glassy White	G4	PF	BF	-	1
S-1	3 (20-30cm bs)			Chert	Mottled Red, White and Black	G4	PF	FF	-	1
S-1	3 (20-30cm bs)			Chert	Yellowish Grey	G4	PF	BF	-	2
S-1	3 (20-30cm bs)			Purcell Argillite	Light Green	G4	PF	CF (3), FF (2)	-	5
S-1	3 (20-30cm bs)			T-O-W Chert	Light Grey	G5	PF	CF (1), BF (2)	-	3
S-1	4 (30-40cm bs)			Quartzite	Dark Brown	G2	PDC	BF	+	1
S-1	4 (30-40cm bs)			Purcell Argillite	Light Green	G2	SDC	CF	+	1
S-1	4 (30-40cm bs)			Quartzite	Dark Red	G3	BTF	BF	-	1
S-1	4 (30-40cm bs)			Chert (Swan River)	Glassy White	G3	IPF	FF	-	2

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-1	4 (30-40cm bs)			Chert (Swan River)	Glassy White	G3	PF	CF (2), BF (1)	-	3
S-1	4 (30-40cm bs)			Purcell Argillite	Dark Green	G3	IPF	BF (2), FF (1)	-	3
S-1	4 (30-40cm bs)			Purcell Argillite	Light Green	G3	PF	CF (3), BF (1)	-	4
S-1	4 (30-40cm bs)			Chert	Dark Brown with Intrusions	G4	PF	BF	-	1
S-1	4 (30-40cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF (2), BF (1), FF (2)	-	5
S-1	4 (30-40cm bs)			Basalt	Dull Black	G4	PF	CF	-	1
S-1	4 (30-40cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF (2), BF (1)	-	3
S-1	4 (30-40cm bs)			Purcell Argillite	Light Green	G4	PF	CF (2), FF (3)	-	5
S-1	4 (30-40cm bs)			T-O-W Chert	Light Grey	G5	SH	SH	-	1
S-1	5 (40-50cm bs)			Purcell Argillite	Light Green	G1	PDC	CF	+	1
S-1	5 (40-50cm bs)			Basalt	Dull Black	G2	IPF	FF	-	1
S-1	5 (40-50cm bs)			Quartzite	White	G2	IPF	FF	-	1
S-1	5 (40-50cm bs)			Purcell Argillite	Light Green	G2	PDC	FF	+	1
S-1	5 (40-50cm bs)			Purcell Argillite	Light Green	G2	IPF	FF	-	1
S-1	5 (40-50cm bs)			Quartzite	Dark Grey	G3	PF	CF	-	1
S-1	5 (40-50cm bs)			Quartzite	Light Brown	G3	BTP	FF	-	1
S-1	5 (40-50cm bs)			Chert (Swan River)	Glassy White	G3	IPF	FF	-	1
S-1	5 (40-50cm bs)			Rhyodacite	Greasy Black	G3	BTF	CF	-	2
S-1	5 (40-50cm bs)			Rhyodacite	Greasy Black	G3	PF	CF	-	1
S-1	5 (40-50cm bs)			Purcell Argillite	Light Green	G3	BTF	BF (1), FF (1)	-	2
S-1	5 (40-50cm bs)			Rhyodacite	Greasy Black	G4	PF	CF	-	1
S-1	5 (40-50cm bs)			Purcell Argillite	Light Green	G4	PF	FF	-	1
S-1	5 (40-50cm bs)			Chert	Tan	G4	PF	CF (1), FF (1)	-	2
S-1	5 (40-50cm bs)			Chert (Swan River)	Glassy White	G4	PF	FF	-	2

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-1	5 (40-50cm bs)			Chert (Swan River)	Glassy White	G4	SH	SH	-	1
S-1	5 (40-50cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF	-	3
S-1	5 (40-50cm bs)			Quartzite	Dark Grey	G5	PF	BF	-	1
S-1	6 (50-60cm bs)			Rhyodacite	Greasy Black	G2	BTF	CF (3), FF (1)	-	4
S-1	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G2	IPF	BF (1), FF (1)	-	2
S-1	6 (50-60cm bs)			Quartzite	Tan	G3	IPF	FF	-	1
S-1	6 (50-60cm bs)			Quartzite	Greyish Brown	G3	IPF	BF	-	1
S-1	6 (50-60cm bs)			Quartzite	Mottled Pink, Grey and Black	G3	PF	CF	-	1
S-1	6 (50-60cm bs)			Rhyodacite	Greasy Black	G3	IPF	BF	-	1
S-1	6 (50-60cm bs)			Rhyodacite	Greasy Black	G3	BTF	CF (1), FF (1)	-	2
S-1	6 (50-60cm bs)			Rhyodacite	Greasy Black	G3	PF	CF (1), FF (1)	-	2
S-1	6 (50-60cm bs)			Chert	Brownish Red	G3	PF	FF	-	2
S-1	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G3	PF	CF	-	1
S-1	6 (50-60cm bs)			T-O-W Chert	Light Grey	G3	PF	CF (2), BF (2)	-	4
S-1	6 (50-60cm bs)			Rhyodacite	Greasy Black	G3	SH	SH	-	1
S-1	6 (50-60cm bs)			Obsidian	Translucent Black	G4	PF	FF	-	1
S-1	6 (50-60cm bs)			Quartzite	Light Grey	G4	PF	BF	-	1
S-1	6 (50-60cm bs)			Rhyodacite	Greasy Black	G4	PF	CF (2), BF (2), FF (2)	-	6
S-1	6 (50-60cm bs)			Purcell Argillite	Light Green	G4	PF	CF (2), FF (1)	-	3
S-1	6 (50-60cm bs)			Chert	Reddish Tan	G4	PF	CF	-	2
S-1	6 (50-60cm bs)			Chert	Mottled Tan, Red, and Black	G4	PF	CF	-	1
S-1	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF (1), FF (2)	-	3
S-1	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G4	SH	SH	-	1
S-1	6 (50-60cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF (3), BF (1)	-	4

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-1	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G5	PF	CF	-	1
S-1	6 (50-60cm bs)			Chert	Tan with Red Intrusions	G5	PF	CF	-	1
S-1	7 (60-70cm bs)			Quartzite	Dark Tan	G2	IPF	FF	-	1
S-1	7 (60-70cm bs)			Quartzite	Banded Grey and Tan	G2	IPF	BF	-	1
S-1	7 (60-70cm bs)			Basalt	Dull Black	G2	PDC	FF	+	1
S-1	7 (60-70cm bs)			Chert (Swan River)	Glassy White	G2	IPF	FF	-	1
S-1	7 (60-70cm bs)			Rhyodacite	Greasy Black	G3	BTF	FF	-	1
S-1	7 (60-70cm bs)			Rhyodacite	Greasy Black	G3	IPF	CF (1), FF (1)	-	2
S-1	7 (60-70cm bs)			Rhyodacite	Greasy Black	G3	PF	CF (2), FF (1)	-	3
S-1	7 (60-70cm bs)			Rhyodacite	Greasy Black	G3	SH	SH	-	2
S-1	7 (60-70cm bs)			Quartzite	Tan	G3	IPF	FF (2), SH (1)	-	3
S-1	7 (60-70cm bs)			Quartzite	Light Grey	G3	PDC	FF	+	1
S-1	7 (60-70cm bs)			Quartzite	Light Tan	G3	IPF	CF (1), FF (1)	-	2
S-1	7 (60-70cm bs)			Quartzite	Pinkish Red	G3	PF	CF	-	1
S-1	7 (60-70cm bs)			T-O-W Chert	Light Blue-Grey	G3	BTF	CF	-	1
S-1	7 (60-70cm bs)			T-O-W Chert	Light Blue-Grey	G3	PF	CF	-	2
S-1	7 (60-70cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	BTF	FF	-	1
S-1	7 (60-70cm bs)			Quartzite	Mottled Red, Brown, and Black	G4	PF	BF	-	1
S-1	7 (60-70cm bs)			Quartzite	Tan and White	G4	PF	BF	-	1
S-1	7 (60-70cm bs)			Rhyodacite	Greasy Black	G4	PF	BF (1), FF (5)	-	6
S-1	7 (60-70cm bs)			Purcell Argillite	Light Green	G4	PF	CF (1), BF (2), FF(3)	-	6
S-1	7 (60-70cm bs)			Chert	Red	G4	PF	BF (2), FF (1)	-	3
S-1	7 (60-70cm bs)			Chert	Tan	G4	PF	CF	-	1
S-1	7 (60-70cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF (3), FF (1)	-	4

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-1	7 (60-70cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF (1), FF (2)	-	3
S-1	7 (60-70cm bs)			Rhyodacite	Greasy Black	G5	SH	SH	-	1
S-1	8 (70-80cm bs)			Quartzite	Reddish Pink	G3	IPF	BF	-	1
S-2	1 (1-10cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	BF	-	1
S-2	2 (10-20cm bs)			Basalt	Dull Black	G2	BTF	CF	-	1
S-2	2 (10-20cm bs)			T-O-W Chert	Banded Grey and Light Grey	G3	BTF	FF	-	1
S-2	2 (10-20cm bs)			T-O-W Chert	Light Grey	G4	PF	FF	-	1
S-2	3 (20-30cm bs)			Chert	Dark Carmel Brown	G3	PF	CF	-	1
S-2	4 (30-40cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	PF	CF	-	1
S-2	5 (40-50cm bs)			Quartzite	Light Grey	G2	SDC	CF	+	1
S-2	5 (40-50cm bs)			Purcell Argillite	Light Green	G3	PF	CF	-	1
S-2	5 (40-50cm bs)			Purcell Argillite	Dark Green	G3	PF	CF (1), BF (1)	-	2
S-2	5 (40-50cm bs)			Chert	Creamy Tan	G4	PF	BF	-	1
S-2	5 (40-50cm bs)			Purcell Argillite	Light Green	G4	PF	CF (1), BF (1)	-	2
S-2	6 (50-60cm bs)			Rhyodacite	Greasy Black	G2	BTF	BF	-	1
S-2	6 (50-60cm bs)			Quartzite	Banded Blue, Grey, and White	G2	IPF	BF	-	1
S-2	6 (50-60cm bs)			Quartzite	Dark Red	G3	BTF	FF	-	1
S-2	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G3	SH	SH	-	1
S-2	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF	-	4
S-2	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G4	SH	SH	-	1
S-2	6 (50-60cm bs)			Purcell Argillite	Light Green	G4	PF	CF	-	1
S-2	7 (60-70cm bs)			Basalt	Dull Black	G2	BTF	CF	-	1
S-2	7 (60-70cm bs)			Purcell Argillite	Dark Green	G3	IPF	FF	-	3
S-2	7 (60-70cm bs)			Basalt	Dull Black	G3	IPF	FF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-2	7 (60-70cm bs)			Quartzite	White	G3	IPF	BF	-	1
S-2	7 (60-70cm bs)			Quartzite	White	G4	PF	BF	-	1
S-2	9 (80-90cm bs)			Rhyodacite	Greasy Black	G2	IPF	CF (1), BF (1)	-	2
S-3	1 (0-10cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	BTF	BF	-	1
S-3	2 (10-20cm bs)			Quartzite	Brownish Grey	G2	IPF	FF	-	1
S-3	3 (20-30cm bs)			Quartzite	Grey	G4	PF	CF	-	1
S-3	4 (30-40cm bs)			T-O-W Chert	Light Grey	G2	IPF	BF	-	1
S-3	4 (30-40cm bs)			Chert	Brownish Red w/intrusions	G3	PF	BF	-	1
S-3	7 (60-70cm bs)			T-O-W Chert	Light Grey	G4	PF	BF	-	1
S-4	1 (0-10cm bs)			Basalt	Dull Black	G2	SDC	CF	+	1
S-4	1 (0-10cm bs)			Quartzite	Grey	G3	IPF	CF	-	1
S-4	1 (0-10cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	BTF	BF	-	1
S-4	1 (0-10cm bs)			Chert	Carmel Brown	G3	PF	CF	-	1
S-4	1 (0-10cm bs)			Chert (Swan River)	Glassy White	G3	BTF	BF	-	1
S-4	1 (0-10cm bs)			Quartzite	Pink and White	G4	SH	SH	-	1
S-4	1 (0-10cm bs)			Chert	Off-White	G4	BTF	CF	-	1
S-4	1 (0-10cm bs)			Chert	Dark Red	G4	PF	CF	-	1
S-4	1 (0-10cm bs)			Chert	Pinkish Red	G4	PF	CF (1), BF (1)	-	2
S-4	1 (0-10cm bs)			Chert	Reddish Tan	G4	PF	BF	-	2
S-4	1 (0-10cm bs)			Chert	Tan	G4	PF	BF	-	1
S-4	1 (0-10cm bs)			Chert	Dark Brown	G4	PF	CF (1), FF (1)	-	2
S-4	1 (0-10cm bs)			Chert	Clear White	G4	PF	BF	-	1
S-4	1 (0-10cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF	-	3
S-4	1 (0-10cm bs)			Purcell Argillite	Light Green	G4	PF	BF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-4	2 (10-20cm bs)			Quartzite	White	G2	IPF	BF	-	1
S-4	2 (10-20cm bs)			Quartzite	Dark Grey	G2	IPF	BF (1), FF (3)	-	4
S-4	2 (10-20cm bs)			Quartzite	Dark Grey	G2	SDC	CF	+	1
S-4	2 (10-20cm bs)			Chert	Creamy White to Tan	G3	SH	SH	+	1
S-4	2 (10-20cm bs)			Chert	Creamy White to Tan	G3	PF	CF	-	1
S-4	2 (10-20cm bs)			Chert	Yellowish Tan	G3	PF	CF	-	3
S-4	2 (10-20cm bs)			Chert	Yellowish Tan w/Black Veins	G3	PF	CF (1), FF (1)	-	2
S-4	2 (10-20cm bs)			Chert	Off-White	G3	PF	CF	-	1
S-4	2 (10-20cm bs)			Chert	Rosie Pink	G3	PF	CF	-	2
S-4	2 (10-20cm bs)			Chert	Dark Red	G3	IPF	FF	-	1
S-4	2 (10-20cm bs)			Chert	Dark Red	G3	PF	BF	-	1
S-4	2 (10-20cm bs)			T-O-W Chert	Light Grey	G3	PF	CF	-	3
S-4	2 (10-20cm bs)			Basalt	Dull Black	G3	BTF'	CF (1), BF (1), FF (1)	-	3
S-4	2 (10-20cm bs)			Purcell Argillite	Light Green	G3	PF	CF (2), BF (2)	-	4
S-4	2 (10-20cm bs)			Quartzite	White	G3	IPF	BF (2), FF (1)	-	3
S-4	2 (10-20cm bs)			Quartzite	Dark Grey	G3	IPF	FF	-	3
S-4	2 (10-20cm bs)			Quartzite	Dark Grey	G3	PF	CF (3), FF (1)	-	4
S-4	2 (10-20cm bs)			Quartzite	Pinkish White	G3	PF	BF	-	1
S-4	2 (10-20cm bs)			Quartzite	Dark Red	G3	PF	BF	-	1
S-4	2 (10-20cm bs)			Chert	Dark Red	G4	PF	CF (10),BF (1)	-	11
S-4	2 (10-20cm bs)			Chert	Tan	G4	PF	CF (4), BF (1), FF (2)	-	7
S-4	2 (10-20cm bs)			Chert	Pink	G4	PF	CF	-	1
S-4	2 (10-20cm bs)			Chert (Swan River)	Glassy White	G4	PF	BF	-	2

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-4	2 (10-20cm bs)			Chert (Swan River)	Glassy White	G4	IPF	FF	-	2
S-4	2 (10-20cm bs)			Chert (Swan River)	Glassy White	G4	SH	SH	-	2
S-4	2 (10-20cm bs)			Basalt	Dull Black	G4	PF	CF (4), FF (1)	-	5
S-4	2 (10-20cm bs)			Quartzite	White	G4	PF	CF (4), BF (1), FF (2)	-	7
S-4	2 (10-20cm bs)			Quartzite	White	G4	SH	SH	-	1
S-4	2 (10-20cm bs)			Quartzite	Grey	G4	PF	CF (2), BF (2)	-	4
S-4	2 (10-20cm bs)			Purcell Argillite	Light Green	G4	PF	CF (1), BF (4)	-	5
S-4	2 (10-20cm bs)			Quartzite	White	G5	PF	BF	-	1
S-4	3 (20-30cm bs)			Quartzite	Grey	G2	IPF	BF	-	1
S-4	3 (20-30cm bs)			Chert (Swan River)	Glassy White	G2	SDC	BF	+	1
S-4	3 (20-30cm bs)			Basalt	Dull Black	G2	IPF	FF	-	1
S-4	3 (20-30cm bs)			Kootenai Argillite	Light Green w/White Crescents	G2	BTF	CF	-	1
S-4	3 (20-30cm bs)			Purcell Argillite	Light Green w/Red Streak	G2	BTF	FF	-	1
S-4	3 (20-30cm bs)			Obsidian	Translucent Black	G3	PF	CF	-	1
S-4	3 (20-30cm bs)			Basalt	Dull Black	G3	IPF	FF	-	1
S-4	3 (20-30cm bs)			Rhyodacite	Greasy Black	G3	BTF	CF (1), BF (1)	-	2
S-4	3 (20-30cm bs)			Rhyodacite	Greasy Black	G3	PF	BF	-	1
S-4	3 (20-30cm bs)			Chert	Pinkish Red	G3	PF	CF	-	1
S-4	3 (20-30cm bs)			Chert	Tan	G3	PF	BF	-	1
S-4	3 (20-30cm bs)			Chert	Dark Brown	G3	PF	CF	-	2
S-4	3 (20-30cm bs)			Chert (Swan River)	Glassy White	G3	IPF	FF	-	2
S-4	3 (20-30cm bs)			Chert (Swan River)	Glassy White	G3	PF	CF	-	1
S-4	3 (20-30cm bs)			Quartzite	Greyish Brown	G3	IPF	CF (1), FF (3)	-	4
S-4	3 (20-30cm bs)			Quartzite	Greyish Brown	G3	PF	BF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-4	3 (20-30cm bs)			Quartzite	Red	G3	PF	FF	-	1
S-4	3 (20-30cm bs)			Quartzite	White	G3	PF	BF	-	4
S-4	3 (20-30cm bs)			T-O-W Chert	Dark Blue-Grey	G3	BTF	CF (1), BF (1)	-	2
S-4	3 (20-30cm bs)			T-O-W Chert	Dark Blue-Grey	G3	PF	BF	-	1
S-4	3 (20-30cm bs)			Purcell Argillite	Light Green	G3	BTF	CF (2), FF (1)	-	3
S-4	3 (20-30cm bs)			Purcell Argillite	Light Green	G3	PF	CF (2), BF (2)	-	4
S-4	3 (20-30cm bs)			Basalt	Dull Black	G4	PF	BF	-	1
S-4	3 (20-30cm bs)			Rhyodacite	Greasy Black	G4	PF	CF (2), BF (1)	-	3
S-4	3 (20-30cm bs)			Chert	Dark Red	G4	RS	CF	-	1
S-4	3 (20-30cm bs)			Chert	Light Pinkish Red	G4	PF	CF (7), FF (2)	-	9
S-4	3 (20-30cm bs)			Chert	Tan	G4	PF	CF (2), BF (2), FF (3)	-	7
S-4	3 (20-30cm bs)			Chert	White	G4	PF	CF (5), BF (5)	-	10
S-4	3 (20-30cm bs)			Chert	White	G4	SH	SH	-	2
S-4	3 (20-30cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF (3), FF (7)	-	10
S-4	3 (20-30cm bs)			Purcell Argillite	Light Green	G4	PF	CF (2), BF (4), FF (6)	-	12
S-4	3 (20-30cm bs)			Quartzite	Off-White	G4	PF	CF	-	3
S-4	3 (20-30cm bs)			Quartzite	Dark Grey	G4	PF	CF (1), FF (5)	-	6
S-4	3 (20-30cm bs)			Quartzite	Tannish Brown	G4	PF	FF	-	4
S-4	3 (20-30cm bs)			Quartzite	Tan	G4	PF	FF	-	3
S-4	4 (30-40cm bs)			Chert	Dark Red	G2	IPF	FF	-	1
S-4	4 (30-40cm bs)			Quartzite	White	G2	PDC	FF	+	1
S-4	4 (30-40cm bs)			Basalt	Dull Black	G3	PF	CF (1), BF (1)	-	2
S-4	4 (30-40cm bs)			Quartzite	White	G3	IPF	FF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-4	4 (30-40cm bs)			Quartzite	Dark Grey	G3	PF	CF (1), BF (1)	-	2
S-4	4 (30-40cm bs)			Quartzite	Tan	G3	SH	SH	-	1
S-4	4 (30-40cm bs)			Quartzite	Pinkish Red	G3	IPF	FF	-	1
S-4	4 (30-40cm bs)			T-O-W Chert	Light Blue-Grey	G3	PF	CF (1), FF (2)	-	3
S-4	4 (30-40cm bs)			Chert (Swan River)	Glassy White	G3	IPF	FF	-	1
S-4	4 (30-40cm bs)			Chert (Swan River)	Glassy White	G3	PF	CF (2), BF (1)	-	3
S-4	4 (30-40cm bs)			Chert	Tan	G3	BTF	FF	-	1
S-4	4 (30-40cm bs)			Chert	Dark Red	G3	PF	FF	-	2
S-4	4 (30-40cm bs)			Purcell Argillite	Light Green	G3	BTF	CF (1), FF (1)	-	2
S-4	4 (30-40cm bs)			Purcell Argillite	Light Green	G3	PF	CF (1), FF (1)	-	2
S-4	4 (30-40cm bs)			Obsidian	Translucent Black	G4	PF	FF	-	1
S-4	4 (30-40cm bs)			Basalt	Dull Black	G4	PF	FF	-	1
S-4	4 (30-40cm bs)			Quartzite	White	G4	PF	BF	-	2
S-4	4 (30-40cm bs)			Quartzite	White	G4	SH	SH	-	3
S-4	4 (30-40cm bs)			Quartzite	Tan	G4	PF	FF	-	2
S-4	4 (30-40cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF	-	2
S-4	4 (30-40cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF (1), FF (2)	-	3
S-4	4 (30-40cm bs)			Chert	Yellowish White	G4	PF	FF	-	3
S-4	4 (30-40cm bs)			Chert	Dark Brown	G4	PF	FF	-	2
S-4	4 (30-40cm bs)			Purcell Argillite	Light Green	G4	PF	CF (5), BF (2), FF (3)	-	10
S-4	4 (30-40cm bs)			Chert	Light Brown	G5	PF	CF (1), BF (1)	-	2
S-4	5 (40-50cm bs)			Basalt	Dull Black	G2	IPF	FF	-	2
S-4	5 (40-50cm bs)			Purcell Argillite	Light Green	G2	BTF	CF	-	1
S-4	5 (40-50cm bs)			Quartzite	White	G2	IPF	CF	-	3

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-4	5 (40-50cm bs)			Quartzite	Greenish Grey	G2	PDC	FF	+	1
S-4	5 (40-50cm bs)			Quartzite	Greenish Grey	G2	IPF	BF	-	1
S-4	5 (40-50cm bs)			Quartzite	Dark Grey	G2	PDC	FF	+	1
S-4	5 (40-50cm bs)			Quartzite	Dark Grey	G2	IPF	BF	-	1
S-4	5 (40-50cm bs)			Basalt	Dull Black	G3	PF	BF	-	1
S-4	5 (40-50cm bs)			T-O-W Chert	Light Blue-Grey	G3	PF	CF (1), BF (2)	-	3
S-4	5 (40-50cm bs)			Chert (Swan River)	Glassy White	G3	PF	CF	-	1
S-4	5 (40-50cm bs)			Chert	Tan	G3	PF	BF	-	1
S-4	5 (40-50cm bs)			Chert	Pinkish Red	G3	PF	CF	-	1
S-4	5 (40-50cm bs)			Purcell Argillite	Light Green	G3	IPF	FF	-	1
S-4	5 (40-50cm bs)			Purcell Argillite	Light Green	G3	PF	CF	-	1
S-4	5 (40-50cm bs)			Purcell Argillite	Light Green	G3	SH	SH	-	1
S-4	5 (40-50cm bs)			Quartzite	White	G3	IPF	BF	-	1
S-4	5 (40-50cm bs)			Quartzite	Greenish Grey	G3	IPF	FF	-	2
S-4	5 (40-50cm bs)			Quartzite	Tan	G3	PF	BF	-	1
S-4	5 (40-50cm bs)			Quartzite	Dark Grey	G3	PF	CF (2), FF (3)	-	5
S-4	5 (40-50cm bs)			Obsidian	Translucent Black	G4	PF	FF	-	1
S-4	5 (40-50cm bs)			Quartzite	White	G4	PF	CF (3), BF (4), FF (4)	-	11
S-4	5 (40-50cm bs)			Quartzite	White	G4	SH	SH	-	3
S-4	5 (40-50cm bs)			Quartzite	Grey	G4	PF	BF	-	1
S-4	5 (40-50cm bs)			Basalt	Dull Black	G4	PF	CF (1), BF (1)	-	2
S-4	5 (40-50cm bs)			Chert	Pinkish White	G4	PF	BF	-	2
S-4	5 (40-50cm bs)			Chert	Tan	G4	PF	CF (2), BF (1)	-	3
S-4	5 (40-50cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF (5), BF (3)	-	8

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-4	5 (40-50cm bs)			Purcell Argillite	Light Green	G4	PF	BF (3), FF (4)	-	7
S-4	5 (40-50cm bs)			Chert	Dark Grey	G5	PF	CF	-	1
S-4	5 (40-50cm bs)			Chert	Tan	G5	PF	CF (1), BF (1)	-	2
S-4	6 (50-60cm bs)			Quartzite	Grey	G1	IPF	FF	-	1
S-4	6 (50-60cm bs)			Quartzite	Off-White	G1	PDC	BF	+	1
S-4	6 (50-60cm bs)			Quartzite	Off-White	G2	SDC	FF	+	1
S-4	6 (50-60cm bs)			Rhyodacite	Greasy Black	G2	SDC	BF	+	1
S-4	6 (50-60cm bs)			Rhyodacite	Greasy Black	G2	IPF	FF	-	1
S-4	6 (50-60cm bs)			Quartzite	Grey	G3	IPF	CF	-	1
S-4	6 (50-60cm bs)			Quartzite	White	G3	IPF	CF (1), FF (3)	-	4
S-4	6 (50-60cm bs)			Chert	Clear to Off-White	G3	PF	CF	-	1
S-4	6 (50-60cm bs)			Chert	Dark Brownish Red	G3	PF	CF	-	1
S-4	6 (50-60cm bs)			Rhyodacite	Greasy Black	G3	PF	BF (2), FF (1)	-	3
S-4	6 (50-60cm bs)			Purcell Argillite	Light Green	G3	IPF	FF	-	1
S-4	6 (50-60cm bs)			Purcell Argillite	Light Green	G3	PF	CF (2), BF (1)	-	3
S-4	6 (50-60cm bs)			Chert	Pinkish Red	G4	PF	CF	-	1
S-4	6 (50-60cm bs)			Chert	Whitish Tan	G4	PF	CF	-	2
S-4	6 (50-60cm bs)			Rhyodacite	Greasy Black	G4	PF	FF	-	1
S-4	6 (50-60cm bs)			Quartzite	White	G4	PF	BF	-	2
S-4	6 (50-60cm bs)			Purcell Argillite	Light Green	G4	PF	BF	-	1
S-4	6(50-60cm bs)			Quartzite	White	G5	PF	CF	-	1
S-4	7 (60-70cm bs)			Quartzite	White	G2	IPF	BF (1), FF (1)	-	2
S-4	7 (60-70cm bs)			Quartzite	Greenish Grey	G2	IPF	FF	-	1
S-4	7 (60-70cm bs)			Chert	Carmel Brown	G2	BTF	BF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-4	7 (60-70cm bs)			Basalt	Dull Black	G3	BTF	CF	-	1
S-4	7 (60-70cm bs)			Basalt	Dull Black	G3	PF	CF	-	1
S-4	7 (60-70cm bs)			Quartzite	White	G3	IPF	FF	-	3
S-4	7 (60-70cm bs)			Purcell Argillite	Light Green	G4	PF	CF (1), BF (1), FF (1)	-	3
S-4	7 (60-70cm bs)			Quartzite	White	G4	PF	CF (2), FF (1)	-	3
S-4	7 (60-70cm bs)			Quartzite	Grey	G5	PF	BF	-	1
S-4	8 (70-80cm bs)			Chert	Carmel Tan	G2	BTF	FF	-	1
S-4	8 (70-80cm bs)			Purcell Argillite	Light Green	G3	PF	BF	-	1
S-4	8 (70-80cm bs)			Quartzite	Greenish Grey	G3	BTF	CF	-	1
S-5	1 (0-10cm bs)			Basalt	Dull Black	G2	IPF	FF	-	1
S-5	1 (0-10cm bs)			T-O-W Chert	Light Grey	G3	BTF	FF	-	2
S-5	1 (0-10cm bs)			T-O-W Chert	Light Grey	G3	PF	CF	-	1
S-5	1 (0-10cm bs)			Quartzite	Light Grey	G4	PF	BF (1), FF (1)	-	2
S-5	1 (0-10cm bs)			T-O-W Chert	Light Grey	G4	PF	BF (2), FF (4)	-	6
S-5	1 (0-10cm bs)			Chert	Greyish White	G4	PF	BF	-	2
S-5	2 (10-20cm bs)			Chert (Swan River)	Glassy White	G3	IPF	BF	-	1
S-5	2 (10-20cm bs)			T-O-W Chert	Light Grey	G3	PF	CF (1), FF (1)	-	2
S-5	2 (10-20cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF (1), BF (1)	-	2
S-5	2 (10-20cm bs)			T-O-W Chert	Light Grey	G4	PF	CF (5), BF (2), FF (2)	-	9
S-5	3 (20-30cm bs)			Quartzite	Light Brownish Grey	G2	IPF	FF	-	1
S-5	3 (20-30cm bs)			Rhyodacite	Greasy Black	G3	IPF	CF	-	1
S-5	3 (20-30cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	PF	CF	-	1
S-5	3 (20-30cm bs)			Rhyodacite	Greasy Black	G4	PF	CF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-5	3 (20-30cm bs)			Quartzite	White	G4	PF	BF	-	1
S-5	3 (20-30cm bs)			Chert	Brownish Red	G4	PF	BF	-	1
S-5	3 (20-30cm bs)			Chert	White and Red	G4	PF	CF	-	1
S-5	3 (20-30cm bs)			T-O-W Chert	Light Grey	G4	PF	CF (1), BF (1), FF (1)	-	3
S-5	4 (30-40cm bs)			Basalt	Dull Black	G3	IPF	BF	-	1
S-5	4 (30-40cm bs)			Chert	White	G3	PF	CF	-	1
S-5	4 (30-40cm bs)			T-O-W Chert	Light Grey	G3	BTF	BF	-	1
S-5	4 (30-40cm bs)			Chert (Swan River)	Glassy White	G4	PF	BF	-	1
S-5	4 (30-40cm bs)			Kootenai Argillite	Light Green w/White Crescents	G4	PF	CF	-	1
S-5	4 (30-40cm bs)			T-O-W Chert	Light Grey	G4	PF	CF (1), BF (2), FF (1)	-	4
S-5	5 (40-50cm bs)			Obsidian	Opaque Black	G3	PF	BF	-	1
S-5	5 (40-50cm bs)			Rhyodacite	Greasy Black	G3	PF	BF	-	1
S-5	5 (40-50cm bs)			Chert (Swan River)	Glassy White	G3	IPF	FF	-	1
S-5	5 (40-50cm bs)			T-O-W Chert	Light Grey	G3	IPF	FF	-	1
S-5	5 (40-50cm bs)			T-O-W Chert	Light Grey	G3	BTF	CF	-	5
S-5	5 (40-50cm bs)			T-O-W Chert	Light Grey	G3	PF	BF (2), FF (2)	-	4
S-5	5 (40-50cm bs)			Rhyodacite	Greasy Black	G4	PF	CF	-	1
S-5	5 (40-50cm bs)			Quartzite	Dark Grey-Black	G4	PF	CF	-	1
S-5	5 (40-50cm bs)			Chert (Swan River)	Glassy White	G4	SH	SH	-	1
S-5	5 (40-50cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF	-	1
S-5	5 (40-50cm bs)			Chert	Brownish Red	G4	PF	CF (2), BF (1)	-	3
S-5	5 (40-50cm bs)			Chert	Tan	G4	PF	CF	-	1
S-5	5 (40-50cm bs)			T-O-W Chert	Light Grey	G4	PF	CF (1), BF (1), FF (1)	-	3

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-5	5 (40-50cm bs)			Kootenai Argillite	Light Green w/White Crescents	G4	PF	FF	-	4
S-5	5 (40-50cm bs)			Kootenai Argillite	Light Green w/White Crescents	G4	SH	SH	-	1
S-5	5 (40-50cm bs)			T-O-W Chert	Light Grey	G5	PF	BF	-	2
S-5	6 (50-60cm bs)			Rhyodacite	Greasy Black	G2	BTF	FF	-	1
S-5	6 (50-60cm bs)			Quartzite	Dark Grey	G3	PF	FF	-	2
S-5	6 (50-60cm bs)			Chert	Reddish Yellow	G3	PF	CF	-	1
S-5	6 (50-60cm bs)			Chert	Greyish Tan	G3	PF	CF	-	1
S-5	6 (50-60cm bs)			T-O-W Chert	Light Grey	G3	BTF	BF	-	1
S-5	6 (50-60cm bs)			T-O-W Chert	Light Grey	G3	PF	BF	-	2
S-5	6 (50-60cm bs)			T-O-W Chert	Light Grey	G3	SH	SH	-	1
S-5	6 (50-60cm bs)			Quartzite	Light Grey	G3	IPF	BF	-	1
S-5	6 (50-60cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	BTF	FF	-	1
S-5	6 (50-60cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	PF	CF (2), FF (2)	-	4
S-5	6 (50-60cm bs)			Chert	Dark Red	G4	PF	BF	-	1
S-5	6 (50-60cm bs)			Chert	Yellowish Tan	G4	PF	CF	-	1
S-5	6 (50-60cm bs)			Rhyodacite	Greasy Black	G4	PF	CF	-	2
S-5	6 (50-60cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF (1), BF (1) FF (1)	-	3
S-5	6 (50-60cm bs)			Purcell Argillite	Dark Green	G4	PF	BF	-	1
S-5	6 (50-60cm bs)			Purcell Argillite	Light Green	G4	BTF	FF	-	3
S-5	6 (50-60cm bs)			Purcell Argillite	Light Green	G4	PF	CF (1), FF (3)	-	4
S-5	7 (60-70cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	BTF	FF	-	1
S-5	7 (60-70cm bs)			Chert	Dark Grey	G4	PF	BF	-	1
S-5	7 (60-70cm bs)			Purcell Argillite	Light Green	G4	PF	BF (1), FF (1)	-	2
S-5	7 (60-70cm bs)			Quartzite	White	G4	PF	FF	-	2

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-5	8 (70-80cm bs)			Chert (Swan River)	Glassy White	G3	IPF	BF	-	1
S-5	8 (70-80cm bs)			Rhyodacite	Greasy Black	G3	PF	CF	-	1
S-5	8 (70-80cm bs)			T-O-W Chert	Light Grey	G3	PF	BF	-	1
S-5	8 (70-80cm bs)			Purcell Argillite	Light Green	G3	IPF	FF	-	1
S-5	8 (70-80cm bs)			T-O-W Chert	Light Grey	G4	PF	CF	-	1
S-5	8 (70-80cm bs)			Quartzite	White w/Black Intrusions	G4	PF	BF	-	1
S-6	1 (0-10cm bs)			Rhyodacite	Greasy Black	G3	PF	BF	-	1
S-6	1 (0-10cm bs)			Quartzite	Light Brown	G3	PF	BF	-	1
S-6	1 (0-10cm bs)			Chert	White	G4	PF	CF	-	1
S-6	2 (10-20cm bs)			Basalt	Dull Black	G3	IPF	FF	-	1
S-6	2 (10-20cm bs)			Quartzite	White	G3	IPF	FF	-	1
S-6	2 (10-20cm bs)			Quartzite	Grey and White	G3	IPF	FF	-	1
S-6	2 (10-20cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	PF	BF	-	1
S-6	2 (10-20cm bs)			Purcell Argillite	Dark Green	G3	IPF	BF	-	1
S-6	2 (10-20cm bs)			Rhyodacite	Greasy Black	G3	PF	CF	-	1
S-6	2 (10-20cm bs)			Chert	Banded White, Grey and Brown	G3	PF	BF	-	1
S-6	2 (10-20cm bs)			Chert	Carmel	G3	PF	CF	-	1
S-6	2 (10-20cm bs)			T-O-W Chert	Dark Grey	G3	BTF	CF (1), BF (1)	-	2
S-6	2 (10-20cm bs)			Basalt	Dull Black	G4	PF	BF	-	1
S-6	2 (10-20cm bs)			Rhyodacite	Greasy Black	G4	PF	CF	-	1
S-6	2 (10-20cm bs)			Quartzite	White	G4	PF	BF	-	1
S-6	2 (10-20cm bs)			T-O-W Chert	Light Grey	G4	PF	CF	-	1
S-6	2 (10-20cm bs)			Chert (Swan River)	Glassy White	G4	PF	CF (2), FF (1)	-	3
S-6	3 (20-30cm bs)			Quartzite	Light Grey	G3	IPF	FF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-6	3 (20-30cm bs)			Chert	Dark Red	G3	BTF	BF	-	1
S-6	3 (20-30cm bs)			Chert	Tan	G3	PF	FF	-	1
S-6	3 (20-30cm bs)			Chert	Mottled White, Brown, Black	G3	PF	CF	-	1
S-6	3 (20-30cm bs)			T-O-W Chert	Dark Blue-Grey	G3	PF	CF	-	1
S-6	3 (20-30cm bs)			Chert (Swan River)	Opaque Glassy White	G3	PF	BF	-	1
S-6	3 (20-30cm bs)			Chert (Swan River)	Translucent Glassy White	G3	PF	CF (1), BF (1)	-	2
S-6	3 (20-30cm bs)			Basalt	Dull Black	G4	PF	CF	-	1
S-6	3 (20-30cm bs)			Chert (Swan River)	Opaque Glassy White	G4	PF	BF (2), FF (1)	-	3
S-6	3 (20-30cm bs)			Quartzite	White	G4	SH	SH	-	1
S-6	3 (20-30cm bs)			T-O-W Chert	Dark Blue-Grey	G4	PF	CF (3), FF (1)	-	4
S-6	4 (30-40cm bs)			Quartzite	Green	G2	IPF	FF	-	1
S-6	4 (30-40cm bs)			Quartzite	Green	G3	IPF	FF	-	1
S-6	4 (30-40cm bs)			Chert	Dark Red	G4	PF	BF	-	1
S-6	4 (30-40cm bs)			T-O-W Chert	Light Grey	G4	PF	FF	-	1
S-6	4 (30-40cm bs)			Purcell Argillite	Light Green	G4	PF	CF	-	1
S-6	5 (40-50cm bs)			Quartzite	White	G3	SH	SH	-	1
S-7	1 (0-10cm bs)			Quartzite	Brown and Black	G2	IPF	FF	-	1
S-7	1 (0-10cm bs)			Basalt	Dull Black	G2	IPF	BF	-	1
S-7	1 (0-10cm bs)			Chert	Dark Tan	G3	PF	CF (1), BF (1)	-	2
S-7	1 (0-10cm bs)			Quartzite	Light Grey	G3	PF	BF	-	1
S-7	1 (0-10cm bs)			Quartzite	Brown and Black	G3	IPF	FF	-	1
S-7	1 (0-10cm bs)			Basalt	Dull Black	G3	IPF	FF	-	2
S-7	1 (0-10cm bs)			Rhyodacite	Greasy Black	G3	PF	CF	-	1
S-7	1 (0-10cm bs)			Rhyodacite	Greasy Black	G3	BTF	BF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-7	1 (0-10cm bs)			Chert	Dark Brown	G4	PF	CF	-	1
S-7	1 (0-10cm bs)			T-O-W Chert	Dark Blue-Grey	G4	PF	CF (1), BF (1)	-	2
S-7	1 (0-10cm bs)			Purcell Argillite	Light Green	G4	PF	CF (1), BF (1)	-	2
S-7	1 (0-10cm bs)			Chert	Whitish Tan	G4	PF	BF (1), FF (2)	-	3
S-7	1 (0-10cm bs)			Chert	Whitish Tan	G5	PF	BF	-	1
S-7	2 (10-20cm bs)			T-O-W Chert	Light Blue-Grey	G2	IPF	FF	-	1
S-7	2 (10-20cm bs)			Chert	Light Tan	G2	BTF	CF	-	1
S-7	2 (10-20cm bs)			Rhyodacite	Greasy Black	G2	SDC	BF	+	1
S-7	2 (10-20cm bs)			Quartzite	Greyish Brown	G2	IPF	FF	-	1
S-7	2 (10-20cm bs)			Purcell Argillite	Light Green	G3	PF	CF (5), BF (5)	-	10
S-7	2 (10-20cm bs)			Purcell Argillite	Light Green	G3	BTF	CF	-	1
S-7	2 (10-20cm bs)			Kootenai Argillite	Dark Green w/White Crescents	G3	PF	CF	-	2
S-7	2 (10-20cm bs)			Quartzite	Dark Grey	G3	BTF	CF (2), FF (1)	-	3
S-7	2 (10-20cm bs)			Quartzite	Dark Grey	G3	PF	CF	-	1
S-7	2 (10-20cm bs)			Quartzite	Pink and White	G3	PF	BF	-	2
S-7	2 (10-20cm bs)			Quartzite	Off-White	G3	PF	CF	-	1
S-7	2 (10-20cm bs)			Quartzite	Yellow and Tan	G3	PF	CF	-	1
S-7	2 (10-20cm bs)			Chert	Carmel w/Black Intrusions	G3	PF	CF	-	1
S-7	2 (10-20cm bs)			Chert	Reddish Tan	G3	PF	BF	-	1
S-7	2 (10-20cm bs)			Chert	Dark Red and Black	G3	PF	BF	-	1
S-7	2 (10-20cm bs)			Chert	Red, Pink, and White	G3	PF	CF	-	2
S-7	2 (10-20cm bs)			Chert	Tan	G3	PF	CF	-	1
S-7	2 (10-20cm bs)			T-O-W Chert	Light Grey	G3	SH	SH	-	1
S-7	2 (10-20cm bs)			Chert (Swan River)	Opaque Glassy White	G3	PF	CF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-7	2 (10-20cm bs)			Chert (Swan River)	Translucent Glassy White	G3	PF	BF	-	1
S-7	2 (10-20cm bs)			Basalt	Dull Black	G3	PF	BF (1), FF (1)	-	2
S-7	2 (10-20cm bs)			Basalt	Dull Black	G3	IPF	FF	-	1
S-7	2 (10-20cm bs)			Rhyodacite	Greasy Black	G3	PF	CF	-	2
S-7	2 (10-20cm bs)			Rhyodacite	Greasy Black	G4	PF	CF (6), BF (2), FF (1)	-	9
S-7	2 (10-20cm bs)			Basalt	Dull Black	G4	PF	CF (1), FF (3)	-	4
S-7	2 (10-20cm bs)			Quartzite	Greyish White	G4	PF	BF	-	3
S-7	2 (10-20cm bs)			Quartzite	Dark Grey	G4	PF	CF (2), FF (1)	-	3
S-7	2 (10-20cm bs)			Quartzite	Tan	G4	PF	BF	-	1
S-7	2 (10-20cm bs)			Purcell Argillite	Light Green	G4	PF	CF (4), FF (1)	-	5
S-7	2 (10-20cm bs)			Chert	Tan	G4	PF	CF (2), BF (2)	-	4
S-7	2 (10-20cm bs)			Chert	Dark Red	G4	PF	CF (1), FF (3)	-	4
S-7	2 (10-20cm bs)			Chert	Reddish Tan	G4	PF	BF	-	2
S-7	2 (10-20cm bs)			Chert	Greyish Tan	G4	PF	FF	-	1
S-7	2 (10-20cm bs)			Chert	Dark Grey	G4	PF	CF (5), FF (2)	-	7
S-7	2 (10-20cm bs)			Chert (Swan River)	Translucent Glassy White	G4	PF	CF (3), BF (2)	-	5
S-7	2 (10-20cm bs)			Chert (Swan River)	Opaque Glassy White	G4	PF	CF (2), FF (1)	-	3
S-7	2 (10-20cm bs)			T-O-W Chert	Light Blue-Grey	G4	PF	CF (8), BF (4), FF (1)	-	13
S-7	2 (10-20cm bs)			T-O-W Chert	Dark Blue-Grey	G4	PF	CF (8), FF (3)	-	11
S-7	2 (10-20cm bs)			T-O-W Chert	Light Blue Grey	G5	PF	CF	-	4
S-7	2 (10-20cm bs)			Chert (Swan River)	Opaque Glassy White	G5	PF	CF	-	1
S-7	2 (10-20cm bs)			Chert	Dark Red	G5	PF	FF	-	1
S-7	3 (20-30cm bs)			Basalt	Dull Black	G2	IPF	BF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-7	3 (20-30cm bs)			Quartzite	Light Red	G3	IPF	FF	-	1
S-7	3 (20-30cm bs)			Chert	Banded Black-White-Tan-Brown	G3	PF	CF	-	1
S-7	3 (20-30cm bs)			Kootenai Argillite	Light Green w/White Crescents	G3	PF	BF	-	1
S-7	3 (20-30cm bs)			Purcell Argillite	Light Green	G3	IPF	FF	-	2
S-7	3 (20-30cm bs)			Purcell Argillite	Light Green	G3	RS	FF	-	1
S-7	3 (20-30cm bs)			Rhyodacite	Greasy Black	G3	BTF	CF	-	2
S-7	3 (20-30cm bs)			Rhyodacite	Greasy Black	G3	PF	CF	-	1
S-7	3 (20-30cm bs)			Chert (Swan River)	Opaque Glassy White	G3	PF	CF (2), BF (1)	-	3
S-7	3 (20-30cm bs)			Chert	Banded Grey, Blue, and Black	G4	PF	CF	-	1
S-7	3 (20-30cm bs)			Chert	Yellowish Tan	G4	PF	CF	-	1
S-7	3 (20-30cm bs)			Chert	Dark Brown and Black	G4	PF	CF	-	3
S-7	3 (20-30cm bs)			Rhyodacite	Greasy Black	G4	PF	CF (3), BF (2)	-	5
S-7	3 (20-30cm bs)			Purcell Argillite	Light Green	G4	PF	BF	-	1
S-7	3 (20-30cm bs)			T-O-W Chert	Light Grey	G4	PF	CF (5), BF (2), FF (2)	-	9
S-7	4 (30-40cm bs)			Rhyodacite	Greasy Black	G2	BTF	BF	-	1
S-7	4 (30-40cm bs)			Chert	Dark Brownish Grey	G2	IPF	CF	-	1
S-7	4 (30-40cm bs)			T-O-W Chert	Light Blue-Grey	G3	PF	CF	-	1
S-7	4 (30-40cm bs)			Quartzite	Brownish White	G3	PF	BF	-	1
S-7	4 (30-40cm bs)			Quartzite	Brownish White	G4	SH	SH	-	1
S-7	4 (30-40cm bs)			Rhyodacite	Greasy Black	G4	PF	CF	-	1
S-7	4 (30-40cm bs)			Chert (Swan River)	Opaque Glassy White	G4	PF	CF (2), BF (1)	-	3
S-7	5 (40-50cm bs)			Rhyodacite	Greasy Black	G4	PF	CF (2), FF (1)	-	3
S-7	5 (40-50cm bs)			Chert (Swan River)	Opaque Glassy White	G4	PF	BF (1), FF (1)	-	2
S-7	6 (50-60cm bs)			Rhyodacite	Greasy Black	G4	PF	CF	-	1

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
S-7	6 (50-60cm bs)			Chert (Swan River)	Opaque Glassy White	G4	RS	CF	-	2
Trench #3	Backhoe Dirt (Near Unit S-1)			Chert	Dark Purple, Red, and Black	G3	IPF	BF	-	1
Trench #3	Backhoe Dirt (Near Unit S-1)			Chert	Dark Tannish Red	G4	PF	CF	-	2
Trench #3	Backhoe Dirt (Near Unit S-1)			Chert (Swan River)	Translucent Glassy White	G4	PF	BF	-	1
Trench #3	Backhoe Dirt (Near Unit S-1)			Chert (Swan River)	Opaque Glassy White	G4	PF	CF	-	1
Trench Fill	Close to Unit S-2			Kootenai Argillite	Light Green w/White Crescents	G3	IPF	FF	-	1
Trench Fill	Close to Unit S-2			Chert	Dark Grey	G3	BTF	CF	-	1
Trench Fill	Close to Unit S-2			Chert	Creamy White	G3	BTF	FF	-	1
Trench Fill	Close to Unit S-2			Chert	Brownish Red	G3	BTF	FF	-	1
Trench Fill	Close to Unit S-2			Basalt	Dull Black	G3	PF	BF	-	1
Trench Fill	Close to Unit S-2			Purcell Argillite	Light Green	G3	PF	BF	-	1
Trench Fill	Close to Unit S-2			Purcell Argillite	Light Green	G4	PF	CF	-	1
Trench Fill	Close to Unit S-2			Kootenai Argillite	Light Green w/White Crescents	G4	PF	CF	-	1
KDC-1	Deep Paleosol		South Wall	Rhyodacite	Greasy Black	G2	BTF	BF	-	1
KDC-1	Deep Paleosol		South Wall	Rhyodacite	Greasy Black	G2	SDC	BF	+	1
KDC-1	Deep Paleosol		South Wall	Kootenai Argillite	Light Green w/White Crescents	G2	IPF	FF	-	1
KDC-1	Deep Paleosol		South Wall	Rhyodacite	Greasy Black	G3	PF	CF (1), FF (1)	-	2

Unit #	Level	Feat. #	Plot	RawMat	Color	Size	Stage	Cond.	Cortex	Count
KDC-1	Deep Paleosol		South Wall	Chert	Dark Blue and Black	G3	PF	CF	-	1
KDC-1	Deep Paleosol		South Wall	Chert	Light Brown	G3	PF	BF	-	1
KDC-1	Deep Paleosol		South Wall	Purcell Argillite	Light Green	G3	PF	CF (1), FF (4)	-	5
KDC-1	Deep Paleosol		South Wall	Kootenai Argillite	Light Green w/White Crescents	G3	BTF	CF	-	2
KDC-1	Deep Paleosol		South Wall	Rhyodacite	Greasy Black	G4	PF	BF	-	1
KDC-1	Deep Paleosol		South Wall	Purcell Argillite	Light Green	G4	PF	CF	-	1
KDC-1	Deep Paleosol		South Wall	Chert (Swan River)	Glassy White	G4	PF	CF	-	1
KDC-1	Deep Paleosol		South Wall	Chert	Light Grey w/Red Intrusions	G4	PF	CF	-	1
KDC-1	Deep Paleosol		South Wall	Chert	Brownish Red	G4	PF	CF	-	1
KDC-1	Deep Paleosol		South Wall	Chert	Dark Brown	G4	PF	CF	-	1
TOTALS		Quartzite = 232 Basalt = 63 Rhyodacite =105 Obsidian =14 Top-Of-The-World (TOW) Chert =190 Swan River Chert =103 Chert =239 Kootenai Argillite =33 Purcell Argillite =161				G1=4 G2=91 G3=413 G4=606 G5=26	PDC=13 SDC=12 IPF=155 BTF=96 PF=821 RS=4 SH=39	CF=465 BF=307 FF=328 SH=40	+ =28 - =1112	1140

KEY: Size Grades-G1=1" and greater
G2=0.5"-0.99"
G3=0.25"-0.49"
G4=0.125"-0.24"
G5=.0625"-0.124"

Condition
CF=complete flake
BF=broken flake (broken with bulb of percussion present)
FF=flake fragment (no bulb of percussion present)
SH=shatter

Cortex
+=present
-=absent

Table 2: Projectile point recording form from 24LN1045.

Cat. #	Unit #	Level	Feat. #	Plot	RawMat	Color	Length-Width Ratio	Total Length (mm)	Basal Width (mm)	Max. Thick (mm)	Blade Length (mm)	Max. Blade Width (mm)	Neck Width (mm)	Depth of Basal Cavity (mm)	Ear Width (mm)	Crtx	Wt (g)
1045/North/surface/1	North side	surface			Quartz	Clear		19.5	15	4.3	11	13.4	8.8	1.7	8	0	1.3
1045/N2/4/1	N-2	4			Kootenai argillite	Light green with white crescents		17	24	5	9	25	18.4	-	-	0	2.5
1045/S1/4/2	S-1	4			Argillite	Grey green		41	13.6	6.6	31	17.8	13.3	-	-	0	4.2
1045/S4/2/3	S-4	2			Chert	Reddish brown and black		36	12.5	5	35	19	-	-	-	0	3
1045/S6/2/1	S-6	2			Chert	Black		17.6	10.6	3	17.7	10.6	-	1	-	0	0.6
1045/S6/3/1	S-6	3			Kootenai argillite	Grey green with white crescents		29	8	4.5	27	27	8	-	7	0	3
1045/S6/4/1	S-6	4			Chert	Mottled grey brown white											
1045/S7/2/1	S-7	2			Basalt	Black		20	11	5	11	16	10	.5	5	0	1.4
1045/KDC-2/South/1	South side				Purcell Argillite	Light green		41	13	6.5	32	19	12	0	-	0	4.7
1045/South/surface/2	South side	surface scrape			TOW chert	Light grey blue		14	12.5	3	8	9.5	7.5	1.5	5.5	0	.55
1045/South/surface/6	South side	surface scrape			TOW chert	Light grey blue		18	9	2	13	11	8.5	.5	4	0	.5
1045/South/surface/7	South side	surface scrape			Opaque Obsidian	Black		18	12	4	11	15	11	1	5	0	1.2
1045/South/surface/8	South side	surface scrape			Kootenai argillite	Light green with white crescents		26	12	3.5	19	21	11	0	-	0	2.0

Table 3: Biface recording form from 24LN1045.

Cat. #	Unit #	Level	Feat. #	Plot	RawMat	Color	Size (cm)	Cond	Stage	Shape	Edges	Crtx	Wt. (G)
1045/N1/1/1	N-1	1 (0-10)			Obsidian	Opaque black	2.8 x 1.9	Fragmentary, transverse break, indeterminate section	II	Lanceolate acute-obtuse	Excurv	none	1.8
1045/N1/2/1	N-1	2 (10-20)			TOW chert	Light blue grey	1.1 x .0.7	Fragmentary, transverse break, proximal portion	IV	???	Straight	none	0.3
1045/N1/2/2	N-1	2 (10-20)			Basalt	Black	4.3 x 1.4	Complete	V	Triangular, distally acute, laterally obtuse	Straight	none	2.2
1045/N1/4/1	N-1	4 (30-40)			Chert	Reddish brown	1.4 x 0.45	Fragmentary, transverse break, distal portion	IV	Lanceolate acute-obtuse	Straight	none	0.4
1045/N2/10/1	N-2	10 (90-100)			Argillite	Light grey	4.4 x 2.3	Complete	I	Ovate, both ends rounded	Excurv	none	10.2
1045/S1/1/1	S-1	1 (0-10)			Chert	Dark brown	3.9 x 1.5	Complete	V	Drill	Straight	none	2.2
1045/S1/4/1	S-1	4 (30-40)			Swan River chert	Opaque glassy white	1.5 x 1.3	Fragmentary, transverse break; midsection	IV	Triangular distally acute, laterally obtuse	Straight	none	0.8
1045/S1/7/1	S-1	7 (60-70)			TOW chert	Light grey	1.2 x 1.3	Fragmentary, transverse break; distal portion	IV	Triangular distally acute, laterally acute	Straight	none	0.27
1045/S2/7/1	S-2	7 (60-70)			Quartzite	White	5.1 x 4.9	Complete	I	Ovate; obtuse both ends	Excurv	none	34.2
1045/S4/2/1	S-4	2 (10-20)			TOW chert	Light blue grey	2.1 x 1.1	Fragmentary, transverse break, distal portion	IV	Lanceolate acute-obtuse	Straight	none	0.9
1045/S4/2/2	S-4	2 (10-20)			Rhyodacite	Dark blue black	2.0 x 1.3	Fragmentary, transverse break, indeterminate portion	III	Ovate, both ends round	Excurv	none	0.9
1045S6/1/1	S-6	1 (0-10)			TOW chert	Light blue grey	0.8 x 1.1	Fragmentary, transverse break, distal portion	IV	Triangular distally acute, laterally acute	Straight	none	0.15
1045/S7/1/1	S-7	1 (0-10)			TOW chert	Light blue grey	1.1 x 0.9	Fragmentary, transverse break, distal portion	IV	Triangulardistally acute, laterally obtuse	Straight	0	0.2
1045/TRF/ S2/1		Trench fill		Close to Unit S-2	Swan River chert	Opaque glassy white	4.3 x 2.0	Fragmentary, lateral break; partial	II	Lanceolate acutely bipointed	Excur	none	5.3
DP/KDC-1/South/2		Deep Paleosol KDC-1		South wall	Purcell argillite	Light green	4.5 x 1.6	Fragmentary, longitudinal break; partial	III	Lanceolate acute and obstuse	Excurv	none	4.7

Cat. #	Unit #	Level	Feat. #	Plot	RawMat	Color	Size (cm)	Cond	Stage	Shape	Edges	Crtx	Wt. (G)
1045/South/ surface/5					Purcell argillite	Light green	4 x 2.3	Complete	I	Triangular distally acute, laterally obtuse	Straight	none	3.4

Table 4: Uniface recording form from 24LN1045.

Cat. #	Unit #	Level	Feat.#	Plot	RawMat	Color	Size (mm)	Form	Shape	Crtex	Wt. (g)
1045/S1/3/2	S-1	3			Kootenai argillite	Light green with white crescents	69 x 25	Knife (double beveled)/distal and lateral edges finished	Triangular	none	13
1045/South/Surface/3		Surface			TOW chert	Light blue grey	32 x 23	End Scraper/distal and lateral edges finished	Irregular	none	6.9
1045/South/Surface/4		Surface			TOW chert	Light blue grey	15 x 13	Scraper/distal and lateral edges finished	Ovate	none	.6

Table 5: Flake tool recording form from 24LN1045.

Cat. #	Unit #	Level	Feat.#	Plot	RawMat	Color	Size (cm)	Form	Crtex	Wt. (g)
1045/N2/1/1	N-2	1			TOW chert	Grey	2.1 x 2.3	Retouched flake, single edge w/acute unifacial retouch	-	1.2
1045/S1/2/1	S-1	2			Heat treated chert	Dark red	2.3 x 1.8	Retouched flake, single edge, w/acute unifacial retouch	-	1.65
1045/S1/3/1	S-1	3		16E, 64S, 25.5 cm bd	Chert	Dark green	4.4 x 3.1	Retouched flake, single edge, w/acute unifacial retouch	-	10.45
1045/S2/2/1	S-2	2			Chert	Dark red mottled black	2.3 x 2.4	Retouched flake, multiple edges, unifacial single edge with acute edge	-	2.2
1045/S4/3/1	S-4	3			Kootenai argillite	Light blue green with white crescents	2.9 x 1.7	Retouched flake, single edge, w/unifacial steep edge	-	1.7

Cat. #	Unit #	Level	Feat.#	Plot	RawMat	Color	Size (cm)	Form	Crtex	Wt. (g)
1045/S4/5/1	S-4	5			Quartzite	Light grey to off- white	2.9 x 1.9	Retouched flake, single edge, w/unifacial steep edge	-	6.3
1045/S4/6/1	S-4	6			Quartzite	Dark grey with white specks	2.9 x 2.1	Retouched flake, single edge, w/unifacial acute edge	-	1.9
1045/S4/8/1	S-4	8			Kootenai argillite	Green with white crescents	2.2 x 1	Retouched flake, multiple edges, bifacial alternation faces w/acute edges	-	0.8
1045/S5/7/1	S-5	7			Rhyodacite	Black	1.5 x 0.9	Retouched flake, multiple edges, bifacial alternating faces w/acute edge	-	0.4
1045/TRF/S2/2	Trench fill	Close to S-2			Chert	Dark grey	3.9 x 2.1	Retouched flake, multiple edges, unifacial alternating acute edges	-	3.9
1045/TR3/1	Trench 3	20 cmbs		1 m E of W end of Trench 3	Purcell argillite	Light green	2.3 x 1.9	Retouched flake, multiple edges, unifacial single edge w/steep edge	-	2.2
1045/S/Surface/1	South side	Surface			Basalt	Dull black	4.7 x 2.9	Retouched flake, single edge, w/unifacial steep edge	+	12.3

Table 6: Core recording form from 24LN1045.

Cat. #	Unit #	Level	Feat.#	Plot	RawMat	Color	Size (cm)	Form	TechType	Crtex	Wt. (g)
1045/S1/3/2	S-1	3			Purcell Argillite	Green	9.6 x 6.3 x 3.7	Blocky	Unprepared blocky	Angular	277.3

Table 7: Core tool recording form from 24LN1045.

Catalog Number	Unit #	Level	Feat. #	Plot	RawMat	Color	Size (cm)	Form	Crtex	Wt. (g)
1045/S7/1/2	S-7	1			Basalt		6.6 x 5.6	Single edge chopper with transverse unifacial work	Round	68.2
1045/DP/KDC-1/South/1	Deep Paleosol	KDC-1		South wall	Basalt	Black	4.9 x 4.3	Single edge chopper with transverse unifacial work	Round	30.3

Table 8: Chipped Stone Disk attributes recording form from Rainy Creek (24LN1045).

Artifact Number	Unit #	Level	Feat. #	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)
1045/S1/1/2b	S-1	1		61.96	45.28	8.18	29.4
1045/S1/1/2c	S-1	1		75.35	54.29	8.98	19
1045/S1/1/2e	S-1	1		80.52	53.9	12.93	30.32
1045/S1/2/2a	S-1	2		76.03	54.84	6.65	46.9
1045/S1/2/2b	S-1	2		73.96	43.72	3.97	22.5
1045/S1/2/2c	S-1	2		64.16	54.16	12.12	58.5
1045/S1/2/2d	S-1	2		57.15	48.85	7.58	29.8
1045/S1/2/4	S-1	2		75.12	57.69	18.76	63.2
1045/S1/2/5	S-1	2		79.77	54.45	6.19	41.8
1045/S1/2/6	S-1	2		70.17	50.37	13.10	39.5
1045/S1/2/7	S-1	2		72.80	53.57	5.09	35.6
1045/S1/2/8	S-1	2		64.29	57.29	3.49	23.9
1045/S1/3/6	S-1	3		54.91	44.05	8.51	25.1
1045/S5/3/1	S-5	3		74.53	61.10	7.93	48.8
1045/TR3/2	Trench 1			72.25	56.14	7.47	39.5

Table 9: Ground/Pecked Stone & Manuport attributes recording form from Rainy Creek (24LN1045).

Artifact Number	Description	Unit #	Level	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
1045/N/Surface/2	Mano/Pestle		Surface	26	3.0	4.0	1100
1045/South/Surface/11	Mano/Pestle		Surface	25.5	3.5	4.0	1000
1045/S7/1/2	Cobble Core/ Chopper	S-7	1	6.6	5.6	3.5	68.2
1045/S7/3/1	Round Stone	S-7	3	4.46	3.83	3.37	76.9
DP/KDC-1/South/3	Manuport Cobble		Surface	19	7.5	3.8	1050
1045/S1/3/5	Manuport Cobble	S-1	3	12	5.6	5.6	600
1045/S4/4/1	Small Pestle	S-4	4	9	2.0	1.5	61.7
1045/S2/1/2	Manuport/Mano	S-2	1	15	6.0	4.0	950
DP/KDC-1/South/4	Grooved Maul	KDC-1	Deep Paleosol	7.4	7.7	4.9	600
1045/KDC-2/S/2	Notched Pebble	KDC-2	trench fill	4	4.0	1.2	64.2
1045/S1/Surface/1	Notched Pebble		Surface	6.5	5.0	1.0	83.5
1045/South/Surface/9	Notched Pebble		Surface	7.6	5.4	1.3	90.5

APPENDIX C:

MODELED HOLOCENE CLIMATIC CHANGE IN THE KOOTENAI RIVER VALLEY, MONTANA

MODELED HOLOCENE CLIMATIC CHANGE IN THE KOOTENAI RIVER VALLEY, MONTANA

Robert U. Bryson
Center for Climatic Research
University of Wisconsin

Introduction: Controls on the Modern Climate

An understanding of airstreams and their relative dominance in a particular region provides insight into the climatological parameters which drive many environmental changes. The relationship of the airstreams to one another and to the local topography defines the climate of the area of interest and diachronic changes in this regime have resulted in corresponding changes in regional climates. Bryson and Hare (1974:18) clearly describe this fundamental relationship:

> The atmospheric circulation has distinctive monthly patterns which interact with surface thermal and topographic characteristics to give each place on earth a particular annual sequence of dominant airstreams. These airstreams, with their physical properties derived from their previous history, plus the dynamics of the locale and its radiation regime, largely determines the climatic character of the place. This defines an annual sequence of assemblages of meteorological parameters which characterize regions delineated by the preferred location of the airstream boundaries.

Precipitation in nearly all of the western states is affected to some extent by the two segments of the Pacific airstream and these, in turn, are considerably influenced by the Cascades and Sierra Nevada. Low-level westerlies typically reach the eastern side of the Cordillera by one of three routes where there are significant passes allowing for their passage into the interior. Moist low-level winds reach the interior almost exclusively: 1) near latitudes 45° to 50° N in British Columbia, where the westerlies are typically the strongest; 2) through the Columbia River-Snake River-Wyoming Basin gap; or 3) by way of the southern "Sonoran" route around the southern end of the Sierra Nevada and then across the lower mountains of southern California (Bryson and Hare 1974:2). This situation results from the fact that most of the low-level winds that encounter the mechanical barrier of the Cascades and Sierra lack sufficient kinetic energy to overcome the effects of stability to the extent that they can pass over the mountains. They are thus typically deflected either northward or to the south, depending on the latitude of the maximum westerlies, unless they follow one of these routes. The lower layers of Pacific air which bring winter precipitation to western Montana typically arrive there by way of the direct trans-Cordilleran route in British Columbia.

Some Pacific air does cross over the Cascades and Sierra to enter the interior directly but this does not come from the lower, moister part of the air column. This air must instead reach the western face of the Cordillera at sufficient altitude to pass over essentially unabated. Wind velocity and air stability primarily determine the height at which this air, already cooler and containing less moisture, passes over the mountains. Under certain conditions moist conditionally stable air may be lifted sufficiently to produce condensation (i.e., through direct orographic uplift) and also pass over the mountains into the interior (Mitchell 1969:107). In either case, as the air descends the eastern slope of the mountains it compresses and warms and its relative humidity decreases, producing an airstream which is milder and drier than that which reached the west coast from the Pacific.

It is clear from the work of numerous authors that a combination of factors act together to produce the complex set of seasonal precipitation patterns of the mountainous west (e.g., Blodgett 1857; Sellers 1968; Houghton 1969; Mitchell 1969, 1976; Bryson and Hare 1974; Court 1974; Hidy and Klieforth 1990; Thompson et al. 1993; and many others). These factors include but are not limited to elevation, latitude, physiography, air flow speed and direction, and air stability and moisture content. Of the many references on the topic, Houghton's 1969 monograph and Mitchell's (1969) dissertation are perhaps most germane to the present discussion because their analyses of observed precipitation and temperature records are based on studies of the synoptic climatology of the mountainous western United States. That is, these authors attempt to relate observed meteorological parameters such as temperatures and precipitation to the locations and interactions of major atmospheric circulation features. This approach is very much in keeping with the methodology employed here to model past climates.

Precipitation patterns over western Montana vary significantly with the season. This results not only because the relative importance of the two oceanic sources of moisture, the Pacific Ocean and the Gulf of Mexico, changes seasonally, but also as a response to the seasonal position, frequency, and nature of the triggering mechanisms causing precipitation. Following Houghton (1969) and Bryson and Hare (1974), three principal triggering mechanisms may be identified: 1) transitory frontal systems moving inland from the Pacific; 2) cyclogenesis occurring inland, chiefly in the lee of the Rockies, notably over Alberta; and 3) convection associated with moist air from the Gulf of Mexico. Of the two principal moisture sources, the Pacific is by far the most important and is particularly prominent during the winter. The low-pressure storm systems carried by the westerlies from the Aleutian low provide a great deal of the precipitation in the region from October through March and the majority of the annual totals. Precipitation during these months, particularly in mid-winter, is triggered by the southward movement of the zone of maximum westerly flow along which polar maritime air from the Gulf of Alaska encounters moist tropical maritime air from the Pacific Ocean, releasing frontal storms carrying snow or rain as far east as the western edge of the Colorado Plateau (Court 1974:213).

Winter precipitation in the Kootenai Valley is largely controlled by the position of what is often referred to as the Alberta storm track which carries cyclonic activity on a northwest to southeast route into the region. Indeed the heaviest precipitation of the year falls during the heart of the winter and largely results from these Pacific frontal storms. The winter season of Pacific precipitation is sometimes altered and lengthened by storms generated in lows over the Rockies themselves. These acquire much of their moisture from the snowpacks of mountains and from lakes at lower elevations. As the seasons progress, however, these storms follow tracks that generally move northward because the westerlies generally become weaker and move farther to the north as the eastern Pacific subtropical high-pressure system expands (Thompson et al. 1993:469). Although there are no truly dry months in the region, this shift in circulation results in a marked reduction in precipitation.

By late spring (May-June), the northward movement of the jetstream core is sufficient to allow a moist tongue of air to move into the area from the south. At this time, convective showers develop as a consequence of the instability created when tropical air originating in the Caribbean, the Gulf of California, or Gulf of Mexico moves northward into the region and encounters colder air from the Pacific. In other words, the area comes under a weak southeasterly current instead of a strong westerly flow (Bryson and Lowry 1955) and brief but intense storms result from the temperature differential between the tropical air masses and those over the continent. This situation might be considered a precursor to the summer monsoonal showers which appear farther to the south. At the beginning of July, a simultaneous westward shift of the Pacific high and a northward shift in the characteristic upper air high over the mid-continent creates conditions in which southeasterly winds aloft carry tropical air as far north as the southwest and parts of the southern Great Basin (Houghton 1969:5) resulting in significant summer rainfall there. In contrast, the Kootenai area receives its lowest monthly precipitation totals during these same summer months because the moist air is no longer carried this far north.

The Present Climate of the Kootenai Valley

Data on mean monthly precipitation, minimum, maximum, and mean temperatures, number of days with rain over 0.01 in, mean snowfall, and other parameters are available from the Western Regional Climate Center, operated by the University of Nevada's Desert Research Institute. Their web site offers such data for all 13 western states, including Alaska and Hawaii: http://www.wrcc.sage.dri.edu/climsum.html. This was the source for all of the precipitation and temperature data used in this study. Such data can also be acquired from other locations on the web, such as at http://www.worldclimate.com and from the National Climatic Data Center (http://www.ncdc.noaa.gov/ol/climate.climatedata.html) which also supplies data in CD-ROM and hard copy forms.

Seasonal distributions of pan evaporation rates (i.e., values that have been actually measured) are not very common, are typically restricted to Class A stations, and may not represent all months. Somewhat more common are rates of potential evapotranspiration which have been calculated from the local temperature, wind speed, and other data, usually following some variation of the Penman-Montieth equations. Calculated evaporation rates taken from Farnsworth and Thompson (1982) for Missoula, Montana were used in this project as no such record exists for Libby itself.

The seasonal distribution of mean monthly precipitation, mean temperature, number of days with rain in excess of 0.01 inches, and mean monthly snowfall at the Libby 1 NE Ranger Station are presented in Table 1, as are the evaporation rates at Missoula. It should be noted that the period of record for all of the these data, with the exception of the calculated evaporation, is the NCDC Normal period of 1961-1990. The period of record for evaporation rates at Missoula runs from 1956-1970 and thus may not be totally comparable to the data from Libby.

A somewhat different graphical representation of these data is found in Figure 1. Depicted in these charts are mean monthly precipitation (Figure1-A), mean number of days of rainfall per month (1-B), mean monthly minimum and maximum temperatures (1-C), and a comparison of monthly mean temperatures with calculated evapotranspiration at Missoula (1-D).

Table 1. **Modern Mean Monthly Climatic Parameters at Libby, Montana[1].**

	Precipitation (mm)	Mean Temp. (°C)	Days Rain > 0.01 in	Snow (mm)	Penman Evap.[2] (Missoula) (mm)
Station No.	245015	245015	245015	245015	245745
Latitude °N	48.40	48.40	48.40	48.40	46.92
Longitude °W	115.53	115.53	115.53	115.53	114.08
Elevation (m)	640.1	640.1	640.1	640.1	975.4
Elevation (ft)	2100.0	2100.0	2100.0	2100.0	3200.0
January	55.4	-4.1	13	475.0	11.2
February	36.8	-0.2	10	208.3	20.1
March	31.2	3.4	10	99.1	46.7
April	27.2	7.9	8	7.6	88.4
May	40.6	12.4	9	0.0	134.9
June	41.1	16.5	9	0.0	154.9
July	27.7	19.4	5	0.0	233.9
August	26.2	19.2	6	0.0	187.2
September	29.5	13.9	8	0.0	102.6
October	33.8	7.8	10	12.7	47.2
November	60.7	1.4	13	175.3	20.1
December	58.4	-3.3	13	467.4	11.7
Annual	468.6	7.9	113	1447.8	1058.7

[1] Source: Western Regional Climate Center; Period of Record: 30 year NCDC Normals (1961-1990).
[2] Source: Farnsworth and Thompson (1982); Period of Record: 1956-1970.

Over forty years ago Bryson and Lahey (1958) climatically defined the "natural seasons" for the present epoch based on the mean positions of major circulation features. In their configuration, "early winter" comprises November and December, "high winter" represents January and February, "late winter" is taken as March up to the 25th of the month. "spring" encompasses April, May, and the first half of June, "summer" includes the last half of June, July, and August, and "fall" constitutes September and October. Because the macrophysical modeling output (described below) and the modern data take the form of monthly means, a modification of the natural seasons is necessary for purposes here. Hence, winter designates November through March, spring equates with April, May, and June, summer is defined as July and August, and fall comprises September and

October. It is important to note that this approach differs from the traditional view of the seasons. Although it is almost never stated explicitly, March is commonly considered part of spring while June is typically treated as a summer month. Similarly, interpretations of paleoenvironmental proxy records do not regularly supply explicit monthly referents for the seasons.

As can be seen in Figure 1, the seasonal distribution of precipitation is dominated by that falling during the winter months as defined above. Nearly 52% of the annual total accumulates during the five months of November through March, while the four months of summer and fall (July through October) see only about 25%. The springtime "monsoonal precursor" described above is seen in the increased precipitation of May and June. The continentality of the region is reflected in the fairly large difference between summer mean minimum and maximum temperatures displayed in Figure 1-C while Figure 1-D demonstrates the close correlation of temperatures and evapotranspiration.

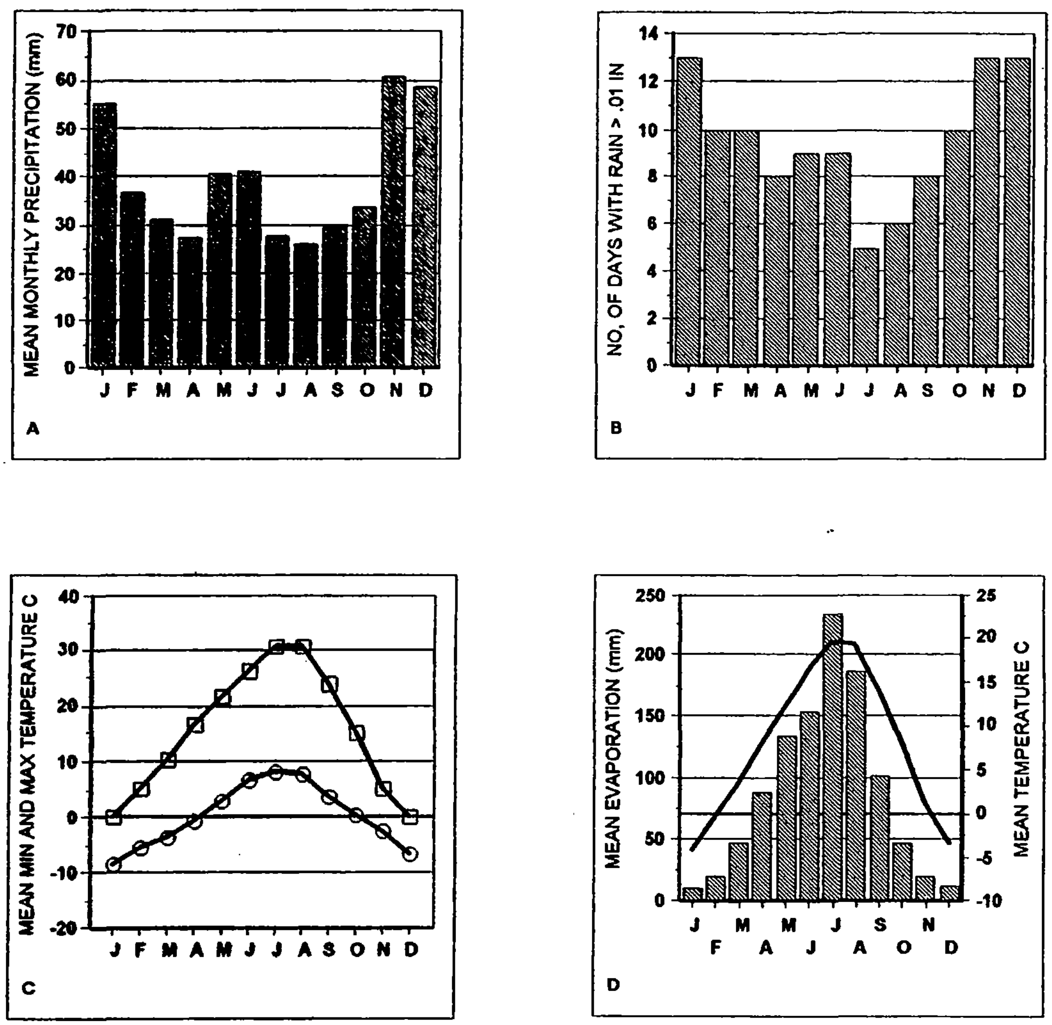

Figure 1. The seasonal distributions of various climatic parameters at Libby, Montana, are presented here. These include the monthly distributions of precipitation (A) and days with precipitation greater than .01 inch (B), as well as mean minimum and maximum temperatures by month (C) and a comparison of mean monthly temperatures with calculated evapotranspiration at Missoula (D).

In his study of the present day climatic conditions affecting montane glaciers in western Montana, Locke (1989) analyzed temperature and snowfall data from 71 U.S. Weather Bureau stations in the area. based on temperatures. When he applied a trend surface analysis through multiple linear regression he was able to explain 80% of the variance in modern (1941-1970) summer (June through August) temperatures across the region on the basis of elevation, northing, and easting. In western Montana, temperature decreases with both elevation and latitude, while increasing slightly as one moves east. This finding implies "a macroscale anomaly of cool air introduction from the northwest and/or warm air from the southeast" (Locke 1989:236). Pertinent here is his interpretation of a temperature gradient of -5.86 ± 0.39 °C per 1000 meters of elevation. When considering paleotemperatures, this relationship might be usefully applied to the model of summer temperatures for Libby presented below to calculate past summer temperatures at nearby sites of interest with known elevations.

Locke (1989) also considered winter precipitation, but looked at data from 265 sites across Montana and adjacent Idaho and Wyoming rather than strictly those from the western portion of the state. He found that "although the statewide regression of precipitation on elevation is virtually useless for prediction [over the state as a whole], the relationship within any small region is strong" (Locke 1989:237). For a variety of reasons he took the situation in the Bozeman area as representative of the state, noting a gradient of 112 ± 18 cm H_2O per 1000 meters of elevation in that region.

As seen in Figure 1-C, there are about five months during which the mean minimum temperature at Libby stays above freezing, however, these averages do not reflect the entire picture on a daily basis. Based on records kept between 1895 and the end of 2000, data available from the Western Regional Climate Center indicate that only 52 days have a 90% probability of remaining frost free and that number only climbs to 90 days if a 50% probability factor is considered. These data are a further indication of the continental nature of the climate in this region.

As noted above, the data for evaporation in Table 1 (and Figure 1-D) do not represent measured values but rather are calculated based on regression equations using estimates of daily wind movement, solar radiation, minimum humidity, and the saturation vapor pressure (Stevens et al. 1981:21). These calculated values also tend to overstate the actual potential evapotranspiration. Nonetheless, a comparison of the precipitation amounts in Table 1 with the evaporation data confirms the obvious, that the area is generally arid, particularly during the summer months. While total annual evaporation more than doubles precipitation, during July it exceeds it by nearly an order of magnitude.

Paleoenvironmental Proxy Records

A brief review of the pertinent literature suggests that to date few paleoenvironmental proxy records from the immediate vicinity of the Kootenai Valley have been analyzed. Thompson et al. (1993) have summarized the paleoclimatic implications of a series of pollen records and packrat middens from locations throughout the western United States. Among these, of principal interest here are the series of pollen records analyzed by Richard Mack and his colleagues from northern

Idaho and northeastern Washington, as well as those from the Kootenai and Fisher River drainages in western Montana.

In their analysis of three cores from Hager Pond in northern Idaho, Mack et al. (1978a) were able to identify five pollen zones constrained by twelve ^{14}C determinations ranging from roughly 9500 to about 2670 years B.P. The vegetation represented by Pollen Zone I (9500-8300 yr B.P.) was likely to have occurred in a macroclimate cooler and moister than today as indicated by the presence of *Pinus albicaulis*, which now only appears in very high elevation forests (1978a:250). The authors suggest that Pollen Zone II (8300-7600 yr B.P.) reflects the beginning of a long warming trend at about 8300 years ago, at which time it was also drier at the site than today. They note that modern analogues of the pollen assemblage from this zone occur in areas with mean July and January temperatures of approximately 21° and 4° C, respectively and precipitation ranging between 375 and 725 mm/yr. Between 7600 and ca. 3000 yr B.P., the contents of Pollen Zone III show a continuation of the warmer, drier conditions seen in the previous period. Between 3000 and 1500 yr B.P. (Pollen Zone IV) there was a rapid increase in the pollen influx of many genera, especially *Pinus*, *Abies*, and *Picea*. The authors state that this zone indicates a comparatively short term change in the climate from warm dry conditions to a regime which was moister and cooler than today. Pollen Zone V suggests that approximately 1500 years ago the modern vegetation of the area became established.

According to Mack et al. (1978b), the pollen record at Big Meadow in northeastern Washington spans roughly the last 12,500 years, based on nine radiocarbon dates ranging from 10,460 ± 320 to 1170 ± 100 yr B.P. The earliest portion of the record, dating to ca. 12,500 to 9700 B.P., is indicative of essentially cold tundra-like conditions in the area. The authors suggest that the Big Meadow pollen assemblage from then until roughly 7000 years ago (Pollen Zone II) shows a change from a basically cool-moist climate to one that is warmer and drier than today. They do, however, note that a problem with this interpretation is the rapid change in time versus sediment depth which occurs over this time period (actually this is a recurring concern for later zones as well). For the subsequent pollen zone (ca. 7000-3300 B.P.), Mack et al. (1978b:962) conclude that there was "a return to slightly moister (but not necessarily warmer) conditions than found in Zone II." By 3300 years ago, the climate in the region apparently became cooler and moister than in the previous two periods. The most recent zone, beginning at about 2400 B.P., represents the emergence of the modern climate in the region.

Eleven radiocarbon determinations ranging from roughly 10,000 to 1970 yr B.P. constrain the chronology of another pollen core analyzed by Mack et al. (1978c). The core taken from Simpson's Flats, Washington, provides a somewhat different interpretation than those described above. There is, however, a major discontinuity in the record from 9000 to 6700 yr B.P. Be that as it may, climatic conditions represented by the four pollen zones may be briefly summarized as follows. Pollen Zone I (10,000-9000 B.P.) was likely cooler and moister than today whereas the period from 6700-4000 B.P. (Pollen Zone II) had conditions that were warmer and drier than today (at Big Meadow this period was apparently moister). The authors suggest that there was a brief reversal of climate to moister (but not necessarily cooler) conditions between 4000 and 2700 B.P.

(Zone III) and that the present vegetation in the vicinity of Simpson's Flats appears to have emerged within the last 2700 years.

In yet another paper, Mack et al. (1978 d) consider the results from each of the three preceding analyses with those derived from a pollen section taken at Waits Lake in the Coville River Valley of northeastern Washington. The Waits Lake core is not quite as well dated as the other three, with eight radiocarbon dates ranging from approximately 11,950 to about 3500 B.P., and concerns expressed by the authors regarding inconsistent bracketing dates for known Mazama and Glacier Peak ashfalls. The initial climate a Waits Lake was largely treeless and occurred in a climate that was considerably cooler and moister than today. At approximately 10,000 years ago, pollen of *Artemisia* and haploxylon pines become gradually less abundant in the spectra, suggesting a switch toward somewhat warmer and drier conditions than before. This trend continued through at least 6700 B.P. and an arid steppe type of *Artemisia* community existed to perhaps 5000 years ago (the dating of this is shaky according to the authors). After 5000 B.P., the pollen record suggests to Mack et al. that conditions became moister and cooler than they had been previously and this allowed the conifers to dominate. However, they found no evidence in their most recent zone (5000? to present) of even a short-term climatic shift to conditions moister and cooler than today

Mack et al. (1979) also examined cores from Mud Lake and Bonaparte Meadow in the Okanogan Valley of Washington. The latter is more concisely described and provides a more complete Holocene record with a chronology constrained by 14 radiocarbon measurements (10,000 ± 220 to 1480 ± 60 yrs B.P.). At about 10,000 yr B.P. the initial vegetation of Bonaparte Meadows was replaced by a large component of *Artemisia*, Gramineae, and diploxylon pines, with an increase in nonarboreal pollen influx, a situation which apparently continued to about 6900 B.P. This pollen assemblage most closely resembles *Artemisia* steppe in the authors' estimation, thus implying "a macroclimate that was warmer and drier than today" (Mack et al. 1979:221). Although it is not clear in their description, their pollen diagram suggests a decrease in moisture from roughly 10,000 B.P. to about 8300 B.P. Although deposition of the subsequent pollen zone, dating to between 6900 and 4800 yr B.P. appears to have been somewhat discontinuous, the pollen diagram presented by Mack et al. indicates that the area underwent a drying trend before moisture increased sharply toward the end of the period. The authors note that although cooling was generally represented after about 6600 years ago in other pollen records from the region, the record here suggests this did not take place until ca. 4800 yr B.P. The pollen assemblage suggests that the modern *Pseudotsuga* forest developed in the Bonaparte Creek Valley after 5000 yr B.P. and that there is little evidence of any reversal of climate to conditions cooler and/or moister than today thereafter.

Finally, Mack et al. (1983) also examined pollen cores from Tepee Lake and McKillop Creek Pond, located about 10 km apart in the drainage basin of the Kootenai River. These two locations lie less than 35 km south-southeast of Libby, Montana, and are among the very few records from the immediate vicinity to have been examined. In general, the pollen records at these two locations are interpreted by the authors as fundamentally substantiating the picture of Holocene vegetation and climate change in the interior Pacific Northwest seen in the pollen records described above. The chronology of the Tepee Lake pollen record was determined largely on the basis of seven radiocarbon dates ranging between 10,680 and 2770 yr B.P. The oldest date taken from the McKillop Creek Pond core is 5930 ± 110 B.P., however, Mack et al. note that the basin should be much older and that the same pollen zonation characterizes the last 6000 years at the two sites despite a difference of 350 m in elevation. A total of five dates (the earliest being 1990 ± 80 yr B.P.), provide temporal control for the McKillop Creek Pond pollen record.

With periglacial conditions still to the north, the ca. 11,000 B.P. climate suggested by Tepee Lake Pollen Zone I was relatively cool and moist based on the predominance of arboreal pollen (although this probably represented a relatively sparse forest). A modern analogue for this inferred community in Idaho has mean January and July temperatures of -5.5°and 15°C, respectively. Mack also suggests that the mix of pollen here, unlike the treeless vegetation suggested by pollen profiles of this date elsewhere, may represent the differential migration rates among species, which in turn is influenced by habitat availability along the route and other factors. At any rate, this forest gave way to more open vegetation by at least 10,680 yr B.P. Unfortunately, the wide ecological amplitude of *Artemisia* and Gramineae, which increase in Pollen Zone II, provide little information on the possible climate during this period (ca. 11,000 to 7100 yr B.P.). Despite this finding, the authors "believe that this pollen zone initiates a long, poorly characterized warming trend from ca. 10,700 yr. B.P. to 7100 yr B.P. ...based chiefly on the change in relative prominence from *Picea* and *Abies* in Zone I to *Larix/Pseudotsuga* in Zone II" (Mack et al. 1983:189). By about 7000 yr B.P., forest apparently became more prominent as indicated by the increase in *Larix/Pseudotsuga* at the start of Pollen Zone III (7100-ca. 4000 B.P.). This shift is interpreted by the authors to be reflective of a warmer, drier climate than is found today in this part of western Montana and they point out that the change seen in this zone is similar in both direction and magnitude with a similarly dated zone from Hagar Pond in northern Idaho.

The most prominent climatic change evidenced by the record in Pollen Zone IV at Tepee Lake and McKillop Creek Pond was probably an increase in annual precipitation. This period (4000 to 2770 yr B.P.) reflects a waning of the warmer, drier conditions of the preceding zone. Notably, there was a pronounced decline in water depth at McKillop Creek Pond that allowed *Sphagnum* peat formation by 3700 yr B.P. During the subsequent period (Pollen Zone V) this water table rose at both sites. The modern western hemlock (*Tsuga heterophylla*) forest which dominates the area today developed sometime after 2770 B.P., although hemlock does not appear consistently in the McKillop Creek Pond record until after 2000 yr B.P. and the date of its appearance elsewhere in the region at large varies considerably.

Macrophysical Paleoclimatic Modeling

Since the advent of the widespread use of computers, the approaches which have been employed to model the climate of the Earth quantitatively can essentially be grouped into three general categories: statistical-dynamical, explicit dynamical, and macrophysical (or archaeoclimatic) modeling. Although these methods all find their antecedents in research that dates to as early as the 17th century, each was designed to serve different purposes, and each produces outputs of distinctive geographical and temporal applicability (see Kutzbach [1985] for a thorough discussion).

Of the three, only the last two have been employed in studies of the earth's climates since the last glacial maximum. Explicit dynamical models, which include the General Circulation Models (GCMs) presently used in forecasts of global warming, deal expressly with day-to-day synoptic-scale weather systems and their associated patterns of precipitation, and so require time steps on the order of minutes to hours for the atmospheric portion of the climate mechanism (Kutzbach 1985:171). The large computational costs of GCMs have largely limited their application in this field to the production of what Kutzbach (1985:172) refers to as "snapshot views of the climate at specific times in Earth's history."

Since the first paleoclimatic experiment using a GCM with a global domain was conducted by Williams et al. (1974) over twenty-five years ago, GCMs have largely been utilized to study alterations in the atmospheric circulation over the last 18,000 years. Easily the best known of these studies have been those carried out by the Cooperative Holocene Mapping (COHMAP) group. Wright et al. (1993) provide a comprehensive overview of the sort of modeling COHMAP members have undertaken and offers comparisons of its output with syntheses of paleoenvironmental proxy data from various regions around the globe. The output of these particular experiments has been in the form of paleoclimatic snapshots of the Northern Hemisphere taken in January and July at 3000 year intervals. A horizontal resolution of roughly 4.5° of latitude and 7.5° of longitude is provided by the models (Kutzbach and Ruddiman 1993:13). COHMAP's goal was to arrive at "an improved understanding of the physics of the climate system, particularly the response of tropical monsoons and mid-latitude climates to orbitally induced changes in solar radiation and to changing glacial-age boundary conditions, such as ice-sheet size" (COHMAP Members 1988:1043).

The methodological basis of most GCMs is essentially microphysical in nature. This means that the equations of motion are used primarily with reference to forces and influences on individual parcels of air, including the effects of as many surface boundary conditions as are computationally (or economically) feasible. In general, this approach starts with these small segments of the atmosphere and through iteration works up to global weather patterns which are then averaged to represent the climate. The iteration is usually with rather short time steps and so climatic simulations of this type may require millions of calculations (Bryson 1993). This factor alone can cause significant error, however, the strongest criticisms of GCMs relate to their coarse spatial resolution and modified treatment of topographic features. As regards the first concern, Street-Perrott (1991:74) notes that key climatic changes (such as models of strengthened Northern Hemisphere monsoons at about 9000 B.P.) depend on only about a 5° shift in the positions of major circulation features which cannot be adequately delimited with current GCM methodology. Further, the spherical harmonics used to simulate the Earth's topography in these models create a situation in which certain of the major geographical features that produce much of the spatial variability of climates are altogether missing (for instance the Sierra Nevada and Cascade ranges), while others are misplaced (Thompson et al. 1993). In general, GCMs do have sufficient resolution to describe variations in large-scale atmospheric circulation patterns. But they cannot accurately simulate smaller-scale circulation features nor achieve the interactions with topography that would likely explain much of the spatial variability found in the climates of many areas (Mock and Bartlein 1995). For these and other reasons, the output of GCM simulations of Holocene climates in the western United States are not discussed here. Thompson et al. (1993) may be consulted for a well-written summary of GCM output applicable in this region.

Until recently, the results of paleoclimatic analyses lacked the specificity needed to adequately evaluate the environmental background against which cultural dynamics have been played out. Without such a background, it is not possible to distinguish between aspects of these processes which are the result of environmental change and those which are more strictly culturally determined. It now appears possible, however, to produce useful site-specific simulations of past climates with a temporal resolution on human scales. Despite the fact that its methodology has only been developed in the past few years, archaeoclimatic modeling offers considerable promise as a means of gaining insight into the specifics of climate change. To date, the results of these simulations have compared favorably analyses of paleoenvironmental proxy data and with the more generalized paleoclimatic reconstructions produced by the GCMs.

Although designed principally with the archaeologist in mind, this technique also has the potential to enhance research in a series of domains within the natural sciences. The modeling results can inform on disciplines as diverse as hydrology, glaciology, geomorphology, and plant and animal ecology and can be applied at scales ranging from that of global warming to the interpretation of individual pollen cores. How useful these simulations will ultimately be can be assessed only in the light of comparison with cultural and paleoenvironmental field data and of further improvements in the modeling and interpretive methodology resulting from continued use of the method and comments from other researchers in the field.

As is the case with many scientific endeavors, the development of Archaeoclimatology has resulted in part from organizing prior knowledge to be of the greatest use to present research. As can be seen in the flowchart depicted in Figure 2, the approach is hierarchical in nature and thus individual aspects of the method can be revised without disrupting the system as a whole. This is an essential consideration when improvements to portions of the system are to be undertaken.

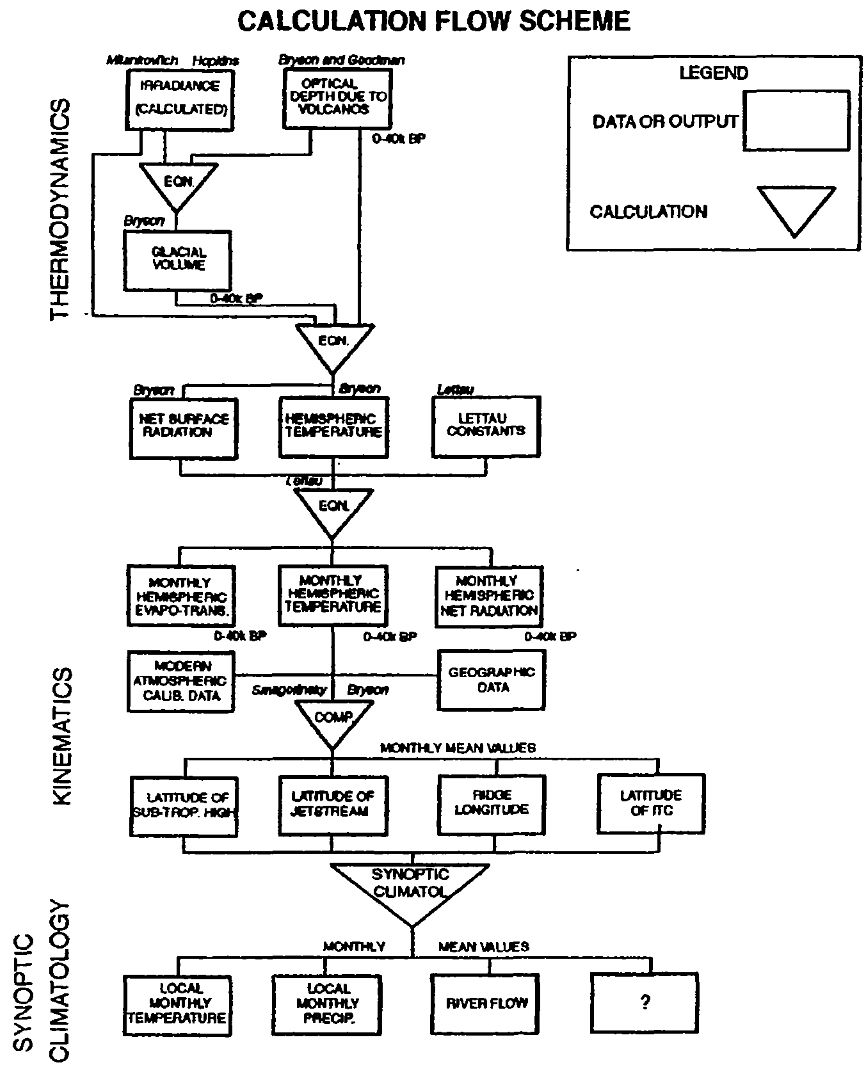

Figure 2. A flow chart summarizing the sequence of calculations used in archaeoclimatic modeling.

In general the method consists of three fundamental components, each of which could be considered models in their own right. In the thermodynamic portion of the flow scheme, changes in the amount of incoming solar radiation over time are incorporated by using calculated values based on the widely accepted "Milankovitch periodicities", gradual shifts in the earth's orbital geometry about the sun first recognized over 50 years ago. The amount of radiation which first enters the atmosphere is not, however, the same as that which reaches the surface of the earth. This situation results from a variety of factors but that considered most important in this approach is the effect of volcanic activity in increasing atmospheric optical depth and thus reducing irradiance at the surface. The application of a technique which takes into account the volcanic modulation of incoming radiation is unique to this method and is critical in that it introduces a set of high frequency terms which account for many of the short-term fluctuations in the earth's climate over time. This approach is based on the graduate research of Brian Goodman who wrote both his Master's and Doctoral theses on this topic. Although highly significant, this work has never been published.

The use of a radiocarbon dated database of global volcanic events lies at the core of the macrophysical modeling methodology. Clearly volcanic aerosols are but one consideration within the suite of potential climatic forcing mechanisms and feedbacks that also includes changes in the Earth's orbital geometry about the Sun and concomitant effects on hemispheric solar irradiance, as well as the consequences of other aerosols, greenhouse gases, and solar variability. To a certain extent, the degree to which each of these mechanisms is comprehended depends on the temporal and geographic scales at which they or their proxies have been observed, measured, modeled or otherwise studied, and on the extent to which they can be isolated from other factors. Perhaps the best known and most widely accepted of these are the Milankovitch (1941) periodicities, which operate on time scales ranging between ca. 5 k and 98 k years and produce outcomes specific to each hemisphere (see, for instance, Wright et al. 1993). It has recently been argued that climatic forcing resulting from solar variability (e.g., Crowley and Kim 1993, 1996, 1999; Rind and Overpeck 1994; Rind et al. 1999) can be tracked on a decadal to centennial scale if properly distinguished from other influences. Anthropogenic greenhouse gases (e.g., IPCC 1992; Mann et al. 1998, 1999) and tropospheric aerosols such as sulfates (e.g., Charlson et al. 1992; Koch et al. 1999), have been implicated in numerous studies for their potential impacts on global temperatures on similar time scales.

By now there is little doubt of the climatic importance of stratospheric volcanic aerosols and there has been a recent surge of interest in this topic. Volcanic eruptions impact the climate system through direct modulation of atmospheric transparency to shortwave radiation. This effect results from an enhancement of the stratospheric aerosol load following the introduction of volcanic material. Prior to about 1970 it was assumed that particulate tephra was the chief volcanic contributor to the aerosol load and that its amount was related directly to the violence of the eruption. As a result of this assumption, for many years only the largest, most violent eruptions were considered climatically important (Franklin 1785; Abbott and Fowle 1913; Humphreys 1913, 1940; Wexler 1951; Mitchell 1961; Lamb 1970). Despite evidence to the contrary, this perception continues to this day mainly because the effects of large eruptions are more readily tracked than those of smaller events.

Studies of temperature changes after the 1963 eruption of Agung volcano in Bali (e.g., Newell 1970, 1981) are representative of some of the early attempts to directly measure the climatic effects of specific volcanic eruptions. Although the existence of sulfuric aerosols was reported over a decade earlier (Junge et al. 1961), it was the development of lidar observing stations in the 1970s (Cadle et al. 1977) which led to the conclusion that it is the gaseous aerosol precursors from volcanic eruptions, rather than the tephra, which provide the principal contribution to the aerosol load of the stratospheric Junge layer (see, for instance, Cadle 1972; Castleman et al. 1974; Cadle and Grams 1975; Hofmann et al. 1975; Sedlacek et al. 1983; Rampino and Self 1984). Subsequent studies of the emissions from the eruptions of Fuego in 1974, Augustine in 1976, Mount St. Helens in 1980, El Chichón in 1982, Redoubt in 1989-90, and Pinatubo in 1991 have been particularly important in confirming this conclusion as well as in demonstrating differences in the potential climatic effects of individual eruptions. For instance, although its local effects on temperature were significant, the climatic impact of the large, violent eruption of Mount St. Helens in 1980 was quite limited. This event brought home the realization that the magnitude of a volcanic eruption (in terms of the volume of its ejecta) may not be as important as its sulfur content when considering ultimate climatic effects (e.g., Robock 1981; Sedlacek et al. 1983; Rampino and Self 1984; Stoiber et al. 1987).

It is now widely accepted that large scale volcanic eruptions produce net cooling at the surface for several years after the event. Indeed, Robock and Mao (1995:1086; see also Hansen et al. 1992) have suggested that large eruptions, such as those of El Chichón and Pinatubo "produced a cooling forcing larger than the warming forcing of all anthropogenic greenhouse gases in the atmosphere at that time." This outcome is generally considered to be the result of an increase in aerosol optical depth largely created by "the chemical transformation and condensation of sulfur-bearing gases (SO_2, OCS) transported into the stratosphere from the troposphere or injected there by large volcanic eruptions" (Turco et al. 1982:234). Injection of sulfur dioxide into the stratosphere (ultimately producing highly reflective H_2SO_4) during the course of explosive volcanism is most widely cited as the climatically effective agent. As Bradley and Jones (1995:606) state today's prevailing consensus:

> "The magnitude of any climatic effect depends on the volume of material ejected and the ejection height, the prevailing (and ensuing) stratospheric circulation pattern, and the chemical composition of the gas and tephra, particularly the amount of sulfur dioxide emitted."

As his work was instrumental in the formulation of the present methodology, a brief discussion of Goodman's findings is appropriate. Goodman (1978, 1984) derived a time series of mean annual Northern Hemisphere (NH) stratospheric aerosol optical depths from pyrheliometric and actinometric observations which he compiled from the literature for 48 NH observing sites. These sources most notably include Kimball (1924, 1927) and Pivovarova (1968, 1977) but also nine others. Goodman individually analyzed each of the stations for which beam radiation intensity measurements were available to remove all local effects due to different scaling factors, sun angles, altitude, Rayleigh scattering, water vapor absorption, ozone absorption, and tropospheric aerosols. Regardless of the format in which the original data were reported, they were converted to mean annual stratospheric optical depths. These individual time series were then areally weighted and averaged to derive a representative time series of hemispheric values from 1883-1980. No comparable set of observations for the Southern Hemisphere was available. In addition to appearing in Goodman's unpublished thesis (1984), the optical depth data may be found as an appendix to Bryson and Bryson (1996).

Goodman (1984) developed simple models to describe the time evolution of the volcanic aerosol enhancements which result from the direct injection (point source) or indirect entrainment (diffuse source) of magmatic sulfur emissions contributed by large and moderate volcanoes respectively. He then constructed a synthetic time series of past fluctuations in the mean annual amount of volcanic mass loading to the stratosphere from 1850-1981 by applying the derived volcanic source function models to each of the large and moderate magmatic eruptions listed in the chronology of Hirschboeck (1980) for that period. Even using this simple dichotomous weighting method for sulfur loadings by eruption size, Goodman's time series accounted for 87% of the *observed* variance in atmospheric optical depth and 77% of the variance in low frequency (i.e., semi-decadal) NH temperature changes over the preceding century. He attributes this latter correlation principally to the effects of the moderate size eruptions in his study. Partitioning his initial data set into latitudinal bands did not affect the outcome of his study. In short, he demonstrated that the measured transparency of the atmosphere over the past century is closely matched by a function of the number of volcanic eruptions, including both large and moderate magmatic eruptions, regardless of individual differences in their actual sulfur content or the size of the eruption.

Subsequent research by Bryson (1989) extended this study to convert a radiocarbon record of past global volcanic activity into a measure of aerosol optical depth based on careful calibration with Goodman's modern data. When this approach is applied in the context of archaeoclimatic modeling, a database of over 2000 radiocarbon dated volcanic eruptions is used to calculate atmospheric optical depth. These data provide the chronological structure of the models. The current temporal resolution of the method, 200 year intervals back to 14,000 B.P. and then 500 year intervals from then back to 40,000 years ago, is limited by the frequency of these dates. The process necessary to improve this temporal framework is presently being undertaken.

The third component of the thermodynamic portion of the modeling methodology revolves around the fact that a portion of the radiation which reaches the surface is reflected back. Much like the aerosol optical depth, the reflectivity, or albedo, of the earth's surface has also not remained constant over time. The modification of surface albedo due to changes in snow and ice cover has dominated all other sources of this variation during the Quaternary. The optical depth and insolation data were combined with a relatively simple model of Pleistocene glaciation driven largely by orbital forcing mechanisms to create an ice albedo time series. This was used to produce a model of glacial area indistinguishable from the field evidence which completes the list of thermodynamic inputs. Together, these are converted into mean monthly hemispheric temperatures through a series of transformations which appeared in the literature of atmospheric sciences about 30 years ago (Lettau 1969).

Within the kinematics portion of the calculation flow scheme (refer to Figure 2) the output of the thermodynamic model is used to calculate the past positions of major circulation features. First, the modeled mean monthly hemispheric temperatures are converted into meridional temperature gradients based on the assumption that equatorial temperatures have remained fairly constant relative to those at the poles. These equator to pole temperature gradients are then used to calculate the mean monthly latitude at which the westerlies become dynamically unstable and curl off into the eddies commonly known as the subtropical anticyclones (highs). This calculation uses a simple equation derived by Smagorinsky in 1963. Using this information and modern atmospheric calibration data it is possible to calculate the past positions of other circulation features, such as the latitude of the jet stream core and the latitude of the intertropical convergence zone at various longitudes.

In general, if the latitude of the jetstreams and the locations of the subtropical anticyclones can be determined over time, then these and other major atmospheric circulation features (formerly called "centers of action") can be used to model local rainfall and precipitation over the same period. This is accomplished through application of the techniques of synoptic climatology, by which the behavior of a climatic element is explained in terms of atmospheric circulation patterns, particularly the positions of the major features. Indeed, in many ways archaeoclimatic modeling can be thought of as synoptic paleoclimatology. This is based on the reasonable premise that, for any particular place, the *relationship* between the monthly positions of the "centers of action" and monthly precipitation (or temperature) has remained essentially constant through the very late Pleistocene and Holocene. In other words, it is assumed that the physics of the situation have remained the same over this period. This relationship can be determined through modern synoptic climatology and calibrated by the multiple regression, not necessarily linear, of the current (i.e., observed) precipitation against the current locations of the pertinent circulation features. It then becomes possible to calculate past monthly precipitation from the modeled past positions of the centers of action.

The modeling output may be site-specific because the means by which the synoptic relationships between precipitation (or temperature) and the major circulation features are calibrated can utilize modern climatic data from a site of interest. As a further result, this modeling methodology is theoretically applicable anywhere on the globe, although there are certain practical limitations to that coverage. In cases where no recording station is located in close proximity to the site, it is sometimes possible to simulate local monthly precipitation and mean temperatures by following an adaptation of Mitchell's (1969) methodology as applied by Bryson and Bryson (1997).

The surface boundary conditions chosen by various researchers using GCMs represent their attempts to quantify explicitly some of the mechanisms, other than the Earth's orbital variations, which have affected atmospheric circulation on a global or hemispheric scale. However, this dimension does not comprehend short term variance in the paleoclimatic record. Nor does it resolve at a regional level the spatial heterogeneity of climates resulting from how the influence of large-scale circulation controls is locally mediated by topography (Whitlock and Bartlein 1993; Whitlock et al. 1995). In contrast to the GCMs, archaeoclimatic modeling works from the premise that, as a first approximation, the volcanic aerosol modulation of insolation embraces enough of the high frequency variance present in the climatic system for short-term paleoclimatic fluctuations to be satisfactorily represented in the models. This is considered to be the case particularly because the methodology also entails the implicit inclusion of internal adjustments between different climatic subsystems through its dependence on the synoptic relationship between circulation features and local conditions, a relationship calibrated by local weather data. In essence this results from the simple truth that the relationship of local conditions to the circulation features is conditioned by the specifics of site topography and regional geography. Often the linkage is nonlinear and must be dealt with as such during calibration. Still, the effects of local conditions are considered in such a fundamental way that they do not usually need to be specified further. This is a big advantage of this type of modeling.

A more complete description of the methodology and underlying assumptions of archaeoclimatic modeling is presented in Bryson and Bryson (1997; 1998). In all, archaeoclimatic models have been constructed for nearly 1500 sites worldwide as of this writing.

Modeled Paleoclimate in the Kootenai River Valley

Following the methodology outlined above it was possible to create macrophysical models of Holocene paleoclimatic conditions in the Kootenai River Valley in the vicinity of Libby, Montana. An algorithm was developed which treats the modern seasonal distribution of precipitation at Libby (see Table 1) as a function of 1) the latitude of the North American jet core at 120°W; 2) the latitude of the North Pacific high axis at 135°W; 3) the latitude of the North Atlantic or "Azores" high axis at 0°W; and 4) the latitude of the intertropical convergence zone (ITC) at 90°W. The latitude of the ITC is related to the extent of the low pressure trough between the Atlantic and Pacific anticyclones (highs). This procedure yielded results which account for 99.2% of the variance in the modern seasonal distribution of precipitation at Libby. Because the past locations of these same "centers of action" have previously been modeled, establishing this synoptic relationship between the modern monthly locations of the circulation features and modern monthly precipitation enables the calculation of past precipitation at the site (Figure 3).

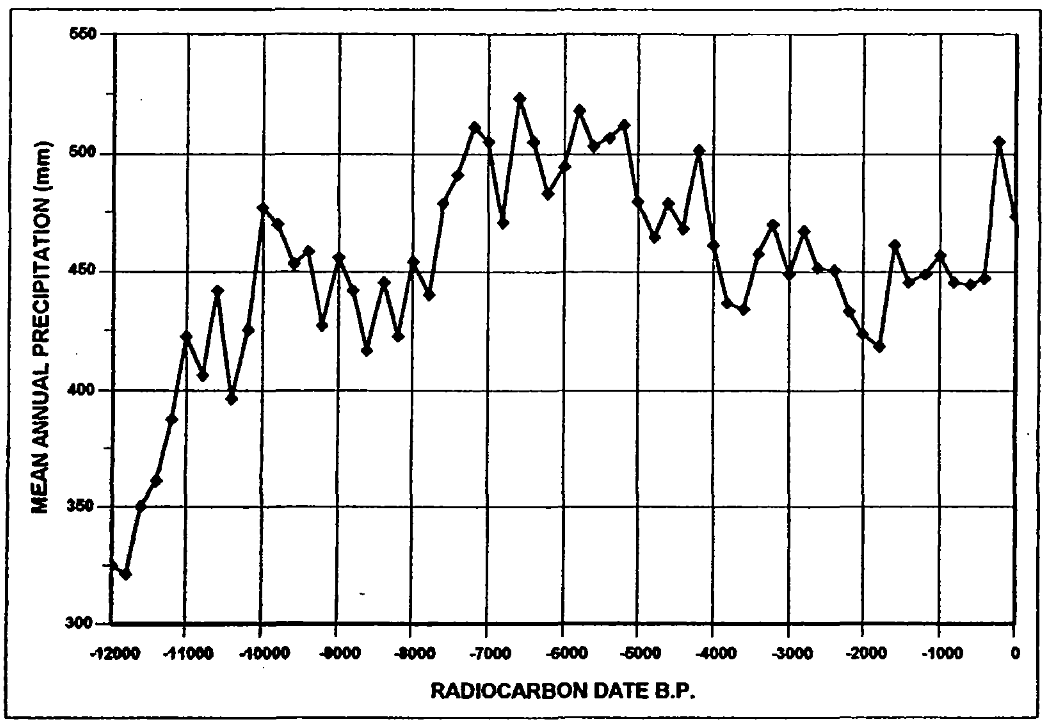

Figure 3. Modeled mean annual precipitation at Libby, Montana, since the close of the Pleistocene. The graph intervals represent two hundred year means and thus remove some of the variance inherent in the model.

The modeled mean monthly values calculated for each 200 year interval were used to produce the graph depicted in Figure 3. However, it is sometimes useful to consider seasonal, rather than annual precipitation totals. Hence the mean values for the winter and spring months as defined by Bryson and Lahey (1958) were summed to create the graphs seen in Figure 4. These seasons were chosen simply because at present they produce roughly three-fourths of the annual totals. Also, as noted above, past winter precipitation at other sites of know elevation within the Kootenai River Valley may be roughly calculated using the equation developed by Locke (1989).

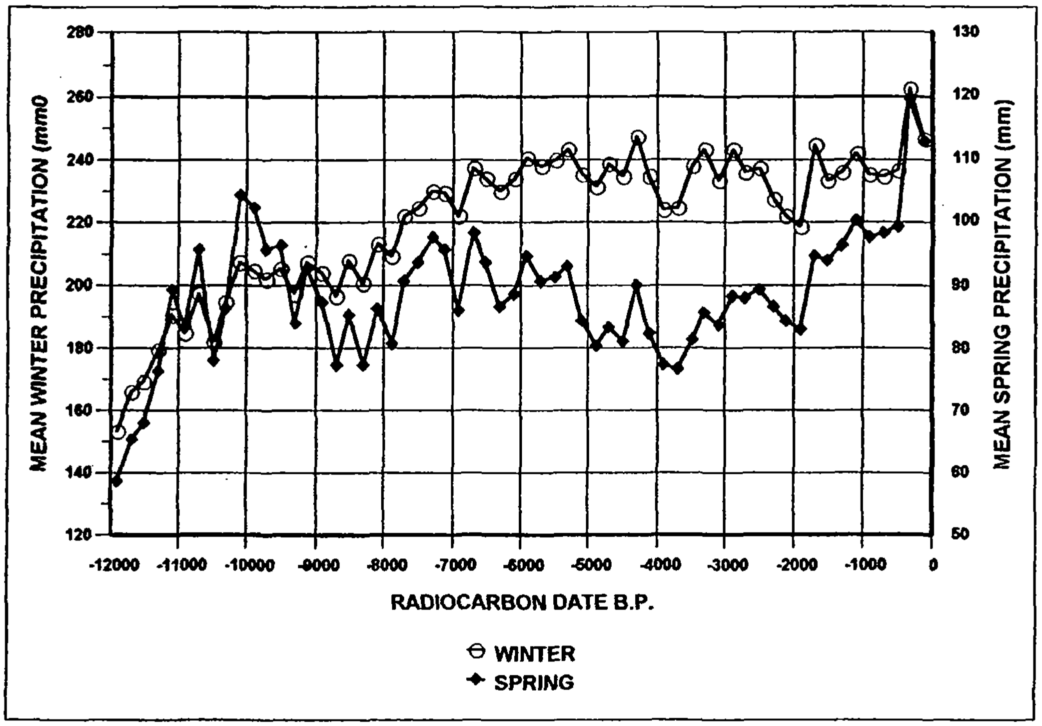

Figure 4. Modeled mean winter (left scale) and spring (right scale) precipitation at Libby, Montana since 12,000 B.P. The seasons follow the definitions given by Bryson and Lahey (1958) and the graph was derived from the same data used to create Figure 3.

As can readily be seen in Figure 4, modeled winter precipitation at Libby has been considerably less variable than that falling during the spring months. Although winter precipitation, as modeled, has increased roughly 40% more or less steadily since the close of the Pleistocene, modeled spring precipitation has almost doubled. In Figure 5 the seasonal distribution of precipitation at Libby is broken out for time periods selected because they represent either relative highs (e.g., 4200 and 6600 B.P.) or lows (1800 and 8600 B.P.) in modeled annual precipitation. It is clear that modeled seasonal precipitation has changed considerably over the Holocene. The steady increase in winter precipitation seen in Figure 4 is also evident here. Most notable are the differences between spring and summer month totals during the relative high and low periods. In addition to a continuing emphasis on winter precipitation, the model suggests a general shift from a summer sub-peak to one taking place earlier in the year. Further, it appears that during extremely low precipitation periods, the summer-turned-spring peak vanishes almost completely, as is the case for the modeled distribution at 1800 B.P.

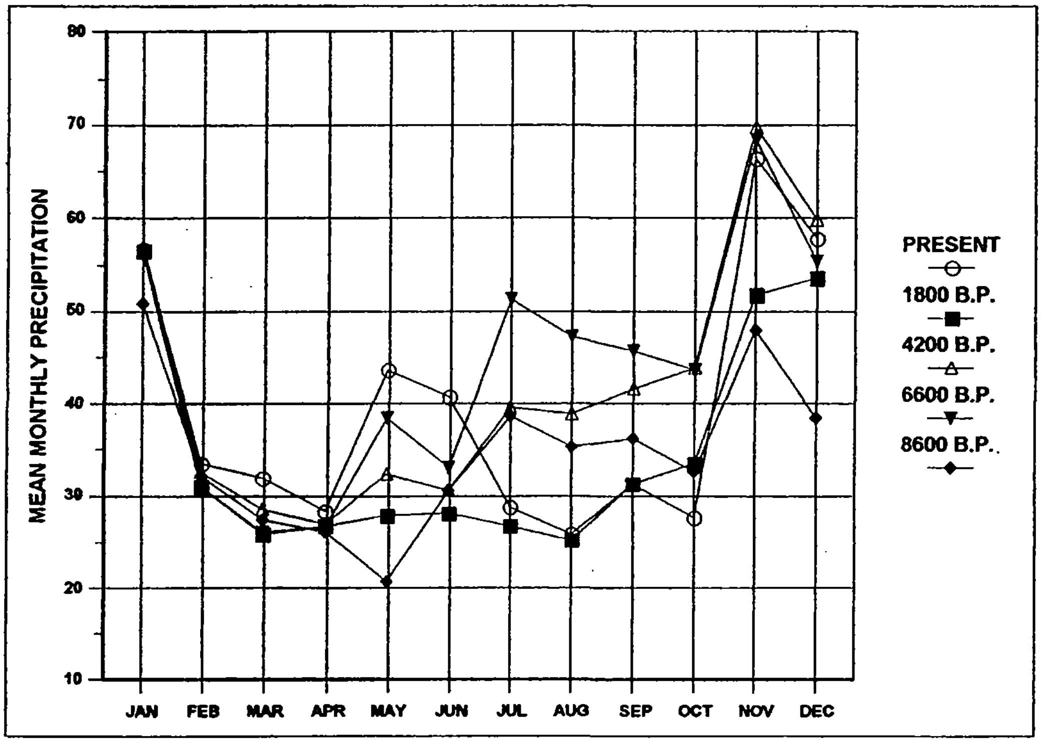

Figure 5. The modeled seasonal distribution of precipitation at Libby, Montana, for selected time periods during the Holocene. These periods were selected because they represent either relative highs (4200 and 6600 B.P.) or lows (1800 and 8600 B.P.) in modeled annual precipitation. Please refer to Figure 3 for modeled annual precipitation.

Figure 6 shows modeled January and July temperatures at Libby since 12,000 B.P. These graphs were produced on the basis of a single model which considered the local temperature to be functionally related to the mean hemispheric temperature and the latitude of the North American jet core at 120°W. This approach produced an algorithim which accounts for 99.5% of the variance in the seasonal distribution of modern mean monthly temperatures at Libby, based on the data presented in Table 1. Locke's (1989) calculated difference of approximately -5.86 °C per 1000 meters of elevation may be used to calculate past temperatures in other locations within the region based on these modeling results. Of interest is the modeled steady increase of winter temperatures over the past 12,000 years while modeled summer temperatures peaked between 7000 and 5000 years B.P. and then have decreased unevenly since then. These changes reflect not only the effects of the changes in the earth's orbital geometry about the sun calculated by Milankovitch but also the higher frequency changes in atmospheric clarity brought about by global volcanic activity.

Although there are several methods which can be employed to calculate potential evapotranspiration rates, they all rely heavily on temperatures. Indeed the correlation between the modern monthly distribution of mean temperatures and evaporation rates seen in Figure 1-D produces an r = .95. In the present case, the calculated seasonal distribution of evaporation at Missoula, Montana, listed in Table 1 was used as a pattern to extrapolate the few months of pan evaporation measured during the summer at Hungry Horse Dam into an annual distribution. This extrapolated series then served as the modern analogue data in a model of evaporation at Hungry

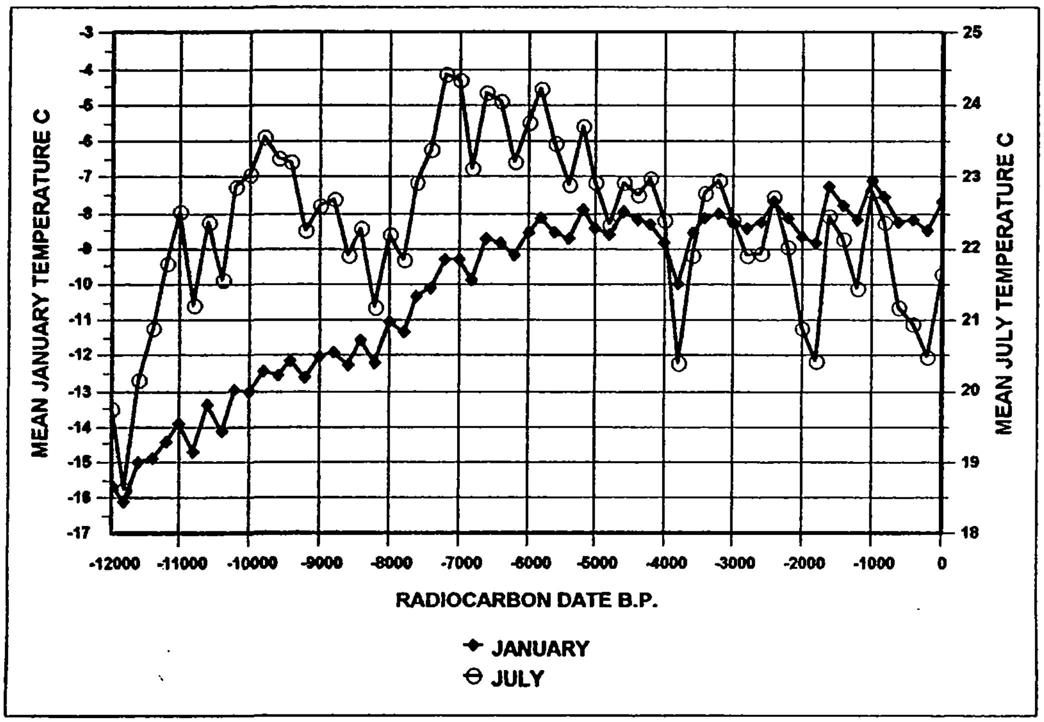

Figure 6. Modeled mean January (left scale) and July (right scale) temperatures at Libby, Montana, for the last 12,000 years. Once again, the graph intervals represent two hundred year means.

that was based on an algorithm employing the saturation vapor pressure and the vapor pressure deficit, calculated on the basis of modern mean and mean minimum temperatures. Modern data were once again acquired from the Western Regional Climate Center. The modeled past pan evaporation was thus calculated from the model of past mean temperatures reflected in Figure 6 along with a model of past mean minimum temperatures (created in the same way as the model of mean temperatures) not shown here for sake of brevity. 97.4% of the variance in the modern seasonal distribution of pan evaporation was accounted for in this model. Although the comparison between modeled evaporation and precipitation shown in Figure 7 is telling, perhaps more effective for understanding modeled past effective moisture is the net of modeled precipitation minus evaporation (P-E) displayed in Figure 8. The data in this figure represent the simple arithmetic difference between the two modeled values expressed as two hundred year means back into the past. Low points in the graph thus represent modeled minima in effective moisture in the region.

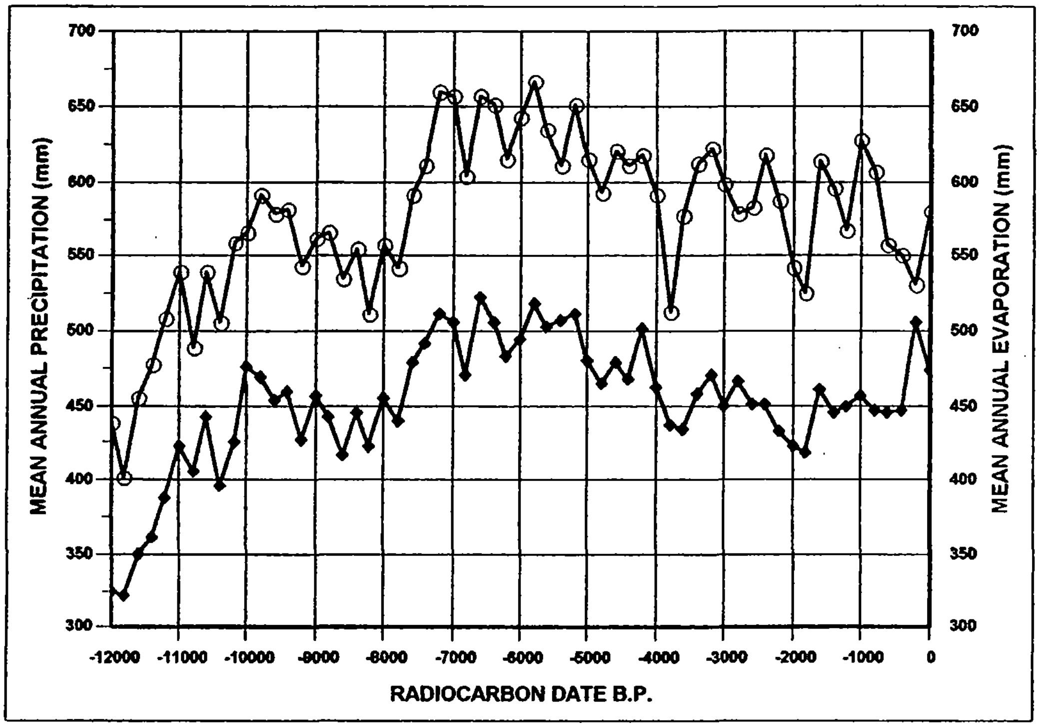

Figure 7. Modeled mean annual precipitation compared with modeled mean annual pan evaporation. Note that the scales are the same and that both calculated and measured modern values were used in the model.

Discussion

Upon inspection of Figure 3, it becomes reasonably clear that modeled mean annual precipitation at Libby, Montana, does not altogether match the pattern of past precipitation regimes Mack and his colleagues have inferred from pollen cores in the Kootenai Valley and elsewhere in the interior Pacific Northwest. Those interpretations were not, however, specific with regard to the seasonality of precipitation during the time periods represented by their various pollen zones. Although their work appears to be quite sound on the whole, there is also the possibility that the effects of changes in temperature and moisture on vegetation communities may not always be readily separable.

The general pattern presented by Mack et al. is one in which the very early Holocene was characterized by conditions that were cooler and wetter than those at present. This regime gave way

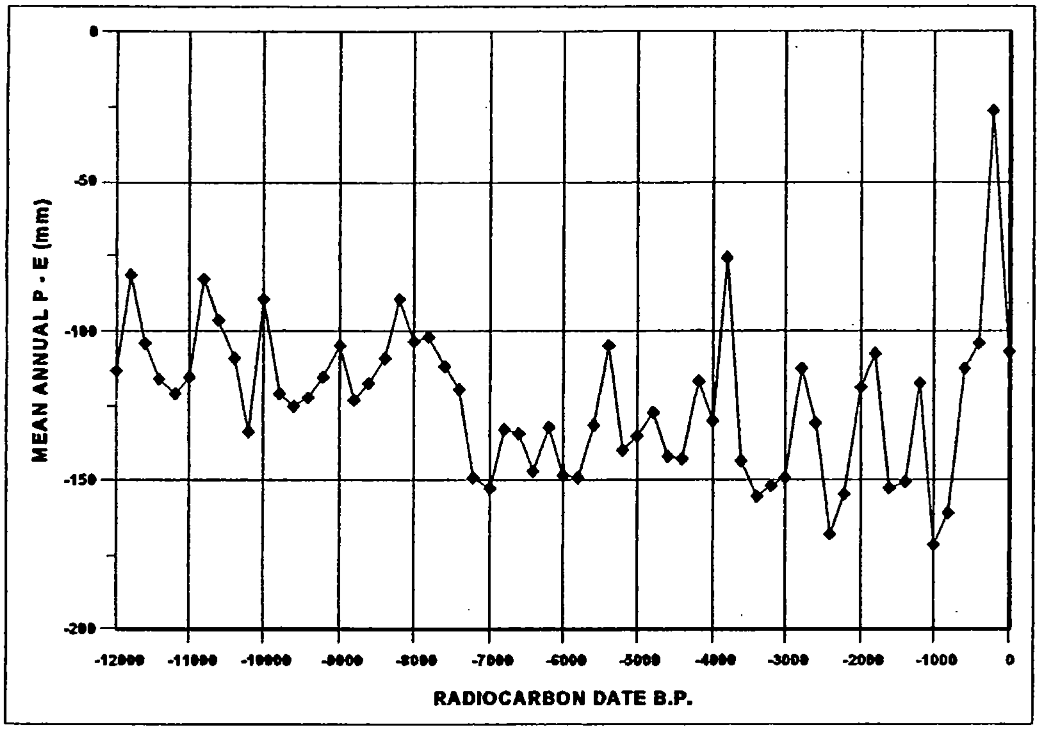

Figure 8. Modeled past effective moisture based on the net between modeled mean annual precipitation and mean annual evaporation. This graph derives from the difference between the two curves depicted in Figure 7.

to a fairly long warming trend that lasted until at least as late as about 7000 yr B.P. The climate of the period between 7000 and 4000 yr B.P. is also characterized by those authors as being warmer and drier than present. A wetter though not necessarily cooler period followed until perhaps 2700 or 2500 B.P. at which time modern vegetation and, presumably, climate became established in the region.

For a variety of reasons it is important to distinguish between seasonal differences in both precipitation and temperatures. It is toward this end that the modeled mean seasonal values of these parameters are offered. Indeed, the annual distribution of precipitation can be viewed as every bit as important in the creation and maintenance of ecosystems as are the annual totals. In general, the modeled summer temperatures seen in Figure 4 largely match the reconstructions based on pollen records summarized above, while the modeled long trend toward higher winter temperatures does not. Similarly, the modeled effective moisture (P-E) comes close to matching the inferred Holocene moisture conditions resulting from those analyses. Taken together, these two models compare quite favorably with the interpretations of past climatic conditions in this region based on the available paleoenvironmental proxy record.

It is the author's intent that the models of paleoclimatic conditions in the Kootenai River area presented above be applied with caution when used to aid in the interpretation of either archaeological materials or paleoenvironmental proxy data. These models, much like interpretations of the pollen cores, should be treated as robust hypotheses about what the climatic portion of the past environment was like. On the whole the models compare reasonably favorably with the proxies which themselves represent mean environmental conditions at a particular location. Determining whether these models and the implications drawn from them regarding paleoclimatic conditions in the Kootenai River Valley are correct will require the acquisition of additional paleoenvironmental proxy records directly from this area and their careful interpretation. Future improvements to the temporal resolution of these models, currently at 200 year intervals, and to other components of the methodology will also aid in this effort.

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APPENDIX D:

SUBCONTRACTED TECHNICAL REPORTS: IMMUNOLOGICAL ANALYSIS AND OBSIDIAN SOURCING ANALYSIS

IMMUNOLOGICAL ANALYSIS OF ARTIFACTS FROM THE RAINY CREEK SITE (24LN1045), MONTANA.

PREPARED FOR

AABERG CULTURAL RESOURCE CONSULTING SERVICE
BILLINGS, MONTANA

by

BIOARCH, INC.
59 Glenpatrick Crescent
Cochrane, AB T4C 1G3

20 August 2001

Introduction

The application of chemical and molecular biological techniques in the analysis of archaeological materials can add significant new information to the interpretation of prehistory. The identification of organic residues from lithic and ceramics artifacts, coprolites and soils can provide archaeologists with specific data regarding prehistoric exploitation of animals and plants. Although ancient protein residues may not be preserved in their original form, linear epitopes are generally conserved which can be identified by immunological methods (Abbas *et al.* 1994). A recent immunological study of 4000-year-old bone from an Egyptian mummy dated to 2150+/-50 BC shows that bone alkaline phosphatase was still viable although the mummy had been embalmed (Weser *et al.* 1995).

Immunological methods have been used to identify plant and animal residues on flaked and groundstone lithic artifacts (Allen *et al.* 1995; Gerlach *et al. 1996;* Henrikson *et al.*, 1998; Hyland *et al.* 1990; Kooyman *et al.* 1992; Newman 1990, 1995; Petraglia *et al. 1996;* Shanks *et al.*1999;Yohe *et al.* 1991) and in Chumash paint pigment (Scott *et al.* 1996). Plant remains on artifacts also been identified through chemical (opal phytoliths), and morphological (use-wear), studies (Hardy and Garufi 1998; Jahren *et al.*,1997, Sobolik 1996). Plant and animal residues on ceramic artifacts have been identified through the use of gas-liquid chromatography, high performance liquid chromatography and mass spectrometry (Bonfield and Heron 1995; Evershed *et al.* 1992; Evershed and Tuross, 1996; Heron *et al.* 1991, Patrick *et al.* 1985). Serological methods have been used to determine blood groups in skeletal and soft tissue remains (Heglar 1972; Lee *et al.* 1989) and in the detection of hemoglobin from 4500-year-old bones (Ascenzi *et al.* 1985). Human leukocyte antigen (HLA) and deoxyribonucleic acid (DNA) determinations made on human and animal skeletal and soft tissue remains have demonstrated genetic relationships and molecular evolutionary distances (Hänni *et al.* 1995; Hansen and Gurtler 1983; Lowenstein 1985, 1986; Pääbo 1985, 1986, 1989; Pääbo et al. 1989). Successful identification of residues on stone tools dated between 35-60,000 B.P. have been made by DNA analysis (Hardy *et al.*, 1997, while residues on surgical implements from the American Civil War were recently identified by immunological and DNA analysis (Newman *et al.*,1998).

The use of forensic techniques in the investigation of archaeological materials is fitting as both disciplines deal with residues that have undergone changes, either deliberate or natural. Criminals habitually endeavor to remove bloodstains by such means as laundering, scrubbing with bleach, etc. yet, such degraded samples are still identified by immunological methods (Lee and De Forest 1976; Milgrom and Campbell 1964; Shinomiya *et al.* 1978, among others). Similarly it has been shown that immunological methods can be successfully applied to ancient human cremations (Cattaneo *et al.*, 1994). Forensic wildlife laboratories use immunological techniques in their investigation of hunting violations and illegal trade, often from contaminated evidence (Bartlett and Davidson 1992; Guglich *et al.* 1994; Mardini 1984; McClymont *et al.* 1982; among others). Immunological methods are also used to test the purity of food products such as canned luncheon meat and sausage, products which have undergone considerable degradation (Ashoor *et al.* 1988;

Berger *et al.* 1988; King 1984). Species identification of cooked meats has also been carried out by DNA hybridization assay (Chikuni *et al.*, 1990). Thus the age and degradation of protein does not preclude detection (Gaensslen 1983:225).

Materials and Methods.

The method of analysis used in this study of archaeological residues is cross-over electrophoresis (CIEP). (Newman 1990). Minor adaptations to the original method were made following procedures used by the Royal Canadian Mounted Police Serology Laboratory, Ottawa (1983) and the Centre of Forensic Sciences (Toronto). The solution used to remove possible residues is 5% ammonium hydroxide which is the most effective extractant for old and denatured bloodstains without interfering with subsequent testing (Dorrill and Whitehead 1979; Kind and Cleevely 1969). Artifacts are placed in shallow plastic dishes and 5.0 mL of 5% ammonia solution applied directly to each. Initial disaggregation is carried out by floating the dish and contents in an ultrasonic cleaning bath for two to three minutes. Extraction is continued by placing the boat and contents on a rotating mixer for thirty minutes. The resulting ammonia solutions are removed and placed in numbered plastic vials, concentrated by lyophilization then reconstituted by the addition of 200μl of sterile distilled water. Approximately one gram (1 g) amounts of each control soil sample is added to 5 mL of Tris buffer (pH 8.0), mixed well and allowed to extract for 24 hours at 4^0C. Concentration of soil supernatant is as for artifact samples. **Duplicate testing is carried out on all positive results.**

Fifteen lithic artifacts from the Rainy Creek Site (24LN1045), Lincoln County, Montana, were submitted for identification of animal protein residues by immunological analysis. Ten of the artifacts were also tested for plant residues. Residues were removed from the artifacts as discussed above. Initial testing of samples was carried out against pre-immune serum (i.e., serum from a non-immunized animal). A positive result against pre-immune serum could arise from non-specific protein interaction not based on the immunological specificity of the antibody (i.e., nonspecific precipitation). No positive reactions were obtained and complete testing of artifacts was continued against the antisera shown in Tables 1 and 2. Antisera from Cappel, produced for use in forensic medicine, provides family level identification only. Additional antisera to elk and pronghorn raised against serum from modern species provide species-specific identification. Antiserum to trout identifies all members of the salmonid family. The plant antisera used was produced against extracts from modern plants and provides family level identification only. The relationship of antisera to possible prey species is shown in Table 3.

TABLE 1: ANIMAL ANTISERA USED IN ANALYSIS.

ANTISERA	SOURCE
BEAR	CAPPEL
BOVINE	"
CAT	"
CHICKEN	"
DEER	"
DOG	"
GUINEA-PIG	"
RABBIT	"
RAT	"
SHEEP	"
TROUT	"
ELK	UNIVERSITY OF CALGARY
PRONGHORN	"

TABLE 2: PLANT ANTISERA USED IN ANALYSIS

ANTISERA	SOURCE
AGAVE	UNIVERSITY OF CALGARY
AMARANTHACEAE	"
CAMAS	"
CAPPARADACEAE	"
CHENOPODIACEAE	"
COMPOSITEAE	"
GRAMINEAE	"
MALVACEAE	"
PINON	"

TABLE 3: POSSIBLE PREY SPECIES IDENTIFIED

ANTISERA TO:	POSSIBLE SPECIES IDENTIFIED
BEAR	BLACK, GRIZZLY
BOVINE	BISON, COW
CAT	BOBCAT, LYNX, MOUNTAIN LION. CAT.
CHICKEN	CHICKEN. TURKEY, QUAIL, GROUSE, PHEASANT
DEER	DEER, ELK, MOOSE, CARIBOU, PRONGHORN.
DOG	COYOTE, WOLF, DOG, FOX.
GUINEA-PIG	PORCUPINE, SQUIRREL, BEAVER, GUINEA-PIG.
RABBIT	RABBIT, HARE, PIKA.
RAT	RAT (ALL SPECIES), MOUSE (ALL SPECIES).
SHEEP	SHEEP, GOAT.

RESULTS

The results of the analysis are shown in Table 4 and discussed below.

One artifact, a biface fragment-point base (# 16), elicited positive reactions to bovine and rabbit. As shown in Table 3 positive reactions to bovine occur against bison and cow, however, unless this area was recently used as pasture the most likely species identified is bison. Rabbit antiserum will identify all members of the order Lagomorpha but the most likely species identified is rabbit. Cross-reactions between bovine and rabbit antisera do not occur thus denoting the presence of two distinct species on the artifact. The blood and/or sinews of one of these may have been used for hafting. Rabbit was also identified on three other artifacts, two projectile points (#s 72 and 77) and a long cobble tool (# 14). The cobble tool also elicited a positive reaction to Chenopodiaceae antiserum indicating a multipurpose use for this tool.

A reaction to deer antiserum was found on one artifact, a biface/point (# 75). As negative results to species-specific elk and pronghorn antisera were obtained the most likely species identified is deer.

Two artifacts, a uniface/knife (# 78) and a mano/pestle (# 80) elicited positive reactions to Capparidaceae antiserum. As previously noted this antiserum affords family level identification only.

No other positive reactions were found in this analysis. The absence of identifiable proteins on artifacts may be due to poor preservation of protein or that they were used on species other than those encompassed by the antisera. It is also possible that the artifacts were not utilized.

TABLE 4 : RESULTS OF ANALYSIS: 24LN1045.

ARTIFACT #	ARTIFACT TYPE	RESULT
16	BIFACE/POINT BASE	BOVINE, RABBIT
75	BIFACE/POINT	DEER
68	DRILL	NEGATIVE
3	STONE DISK	NEGATIVE
52	STONE DISK	NEGATIVE
11	RETOUCHED FLAKE	NEGATIVE
78	UNIFACE/KNIFE	CAPPARADACEAE
72	PROJECTILE POINT	RABBIT
77	PROJECTILE POINT	RABBIT
14	LONG COBBLE	RABBIT, CHENOPOD
71	PROJECTILE POINT	NEGATIVE
80	MANO/PESTLE	CAPPARADACEAE
9	END SCRAPER	NEGATIVE
46	UNMODIFIED COBBLE	NEGATIVE
47	GROOVED MAUL	NEGATIVE

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Geochemical Research Laboratory Letter Report 2001-63

August 2, 2001

Mr. Stephen A. Aaberg
Aaberg Cultural Resource Consulting Service
2909 East MacDonald Drive
Billings, Montana 59102

Dear Steve:

On page two of this letter you will find a table presenting energy dispersive x-ray fluorescence (edxrf) data generated from the analysis of two obsidian artifacts from the Rainy Creek site (24LN1045), Lincoln County, northwestern Montana. Although you sent three artifacts for analysis, one of them (cat. no. 1045/S5/L5/2) was too small (i.e. < ca. 9-10 mm diameter) and/or thin (i.e. < ca. 1.5 mm thick) to generate x-ray counting statistics adequate for proper conversion from background-corrected intensities to quantitative concentration estimates (i.e., ppm) by xrf. The xrf research reported herein was completed pursuant to your letter request of July 25, 2001.

Analyses of obsidian are performed at my laboratory on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray fluorescence spectrometer equipped with a rhodium (Rh) x-ray tube, a 50 kV x-ray generator, with microprocessor controlled pulse processor (amplifier) and bias/protection module, a 100 mHz analog to digital converter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 160 eV resolution (FWHM) at 5.9 keV in a 30 mm² area. The x-ray tube is operated at 34.0 kV, .26 mA, using a .127 mm Rh primary beam filter in an air path to generate x-ray intensity data for elements zinc (Zn Kα), gallium (Ga Kα), rubidium (Rb Kα), strontium (Sr Kα), yttrium (Y Kα), zirconium (Zr Kα), and niobium (Nb Kα). Barium (Ba Kα) intensities are generated by operating the x-ray tube at 50.0 kV, .35 mA, with a .63 mm copper (Cu) filter, while those for titanium (Ti Kα), manganese (Mn Kα) and total iron ($Fe_2O_3^T$) are generated by operating the x-ray tube at 15.0 kV, .30 mA with a .127 mm aluminum (Al) filter. Iron vs. manganese (Fe Kα/Mn Kα) ratios are computed from data generated by operating the x-ray tube at 15.0 kV, .30 mA, with a .127 mm aluminum (Al) filter. Deadtime-corrected analysis time for each sample appears in the data table.

X-ray spectra are acquired and elemental intensities extracted for each peak region of interest, then matrix correction algorithms are applied to specific regions of the x-ray energy spectrum to compensate for inter-element absorption and enhancement effects. After these corrections are made, intensities are converted to concentration estimates by employing a least-squares calibration line established for each element from analysis of up to 30 international rock standards certified by the U.S. Geological Survey, the U.S. National Institute of Standards and Technology, the Geological Survey of Japan, the Centre de Recherches Petrographiques et Geochimiques (France), and the South African Bureau of Standards. Further details pertaining to x-ray tube operating conditions and calibration appear in Hughes (1988, 1994b). Extremely small/thin specimens are analyzed using a .25 mm² primary beam collimator, and resulting data normalized using a sample mass correction algorithm. Deadtime-corrected analysis time is greatly extended in all instances when primary beam collimation is employed.

Trace element measurements on the xrf data table are expressed in quantitative units (i.e. parts per million [ppm] by weight), and matches between unknowns (the artifacts you sent) and known obsidian chemical groups are made on the basis of correspondences (at the 2-sigma level) in diagnostic trace element concentration values (in this case, ppm values for Rb, Sr, Y, Zr, Nb, Ba, Ti, Mn and $Fe_2O_3^T$) that appear in Anderson et al. (1986), Baugh and Nelson (1987, 1988), Glascock et al. (1999), Hughes (1984), Hughes and Nelson (1987), Jack (1971), Nelson (1984), Shackley (1995, 1998), and unpublished data on other Utah and Wyoming obsidians (Hughes 1994a; 1995a, b; 1997). Artifact-to-obsidian source (geochemical type, *sensu* Hughes 1998) correspondences were considered reliable if diagnostic mean measurements for artifacts fell within 2 standard deviations of mean values for source standards. I use the term "diagnostic" to specify those trace elements that are well-measured by x-ray fluorescence, and whose concentrations show low intra-source variability and marked variability across sources. In short, diagnostic elements are those concentration values allowing one to draw the clearest geochemical distinctions between sources (Hughes 1990, 1993). Although Zn, Ga and Nb ppm concentrations also were measured and reported for each specimen, they are not considered "diagnostic" because they don't usually vary significantly across obsidian sources (see Hughes 1982, 1984). This is particularly true of Ga, which occurs in concentrations between 10-30 ppm in nearly all parent obsidians in the study area. Zn ppm values are infrequently diagnostic; they are always high in Zr-rich, Sr-poor peralkaline volcanic glasses, but otherwise they do not vary significantly between sources in the study area vicinity.

The trace element composition measurements in the enclosed table are reported to the nearest ppm to reflect the resolution capabilities of non-destructive energy dispersive x-ray fluorescence spectrometry. The resolution limits of the present x-ray fluorescence instrument for the determination of Zn is about 3 ppm; Ga about 2 ppm; for Rb about 4 ppm; for Sr about 3 ppm; Y about 2 ppm; Zr about 4 ppm; Nb about 2 ppm; and Ba about 10 ppm (see Hughes [1994b] for other elements). When counting and fitting error uncertainty estimates (the "±" value in the table) for a sample are greater than calibration-imposed limits of resolution, the larger number is a more conservative indicator of composition variation and measurement error arising from differences in sample size, surface and x-ray reflection geometry.

	Trace Element Concentrations											Ratio	
Cat. Number	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Ti	Mn	$Fe_2O_3^T$	Fe/Mn	Obsidian Source (Chemical Type)
N1/1/1	73 ±6	21 ±3	228 ±4	6 ±3	72 ±3	152 ±4	39 ±3	nm	517 ±16	246 ±11	1.41 ±.10	nm	Obsidian Cliff, WY
N2/L2/1*	48 ±5	13 ±3	130 ±4	67 ±3	22 ±3	107 ±4	10 ±3	1472 ±19	nm	nm	nm	nm	Malad, ID

Values in parts per million (ppm) except total iron [in weight %] and Fe/Mn intensity ratios; ± = expression of x-ray counting uncertainty and regression fitting error at 300 and 600 (*) seconds livetime. nm= not measured.

Xrf data indicate that one artifact has the same trace element composition as volcanic glass of the Obsidian Cliff geochemical type, Wyoming (cf. Anderson et al. 1986: Table 4; Hughes 1995a: Table 2), while the small flake has the same geochemical composition as obsidian from Malad, Idaho (cf. Hughes 1984: Table 3; Nelson 1984: Table 5, source # 31).

I hope this information will help in your analysis and interpretation of other materials from this site. Please contact me at my laboratory ([650] 851-1410; e-mail: rehughes@silcon.com) if I can be of further assistance.

Sincerely,

Richard E. Hughes

Richard E. Hughes, Ph.D.
Director, Geochemical Research Laboratory

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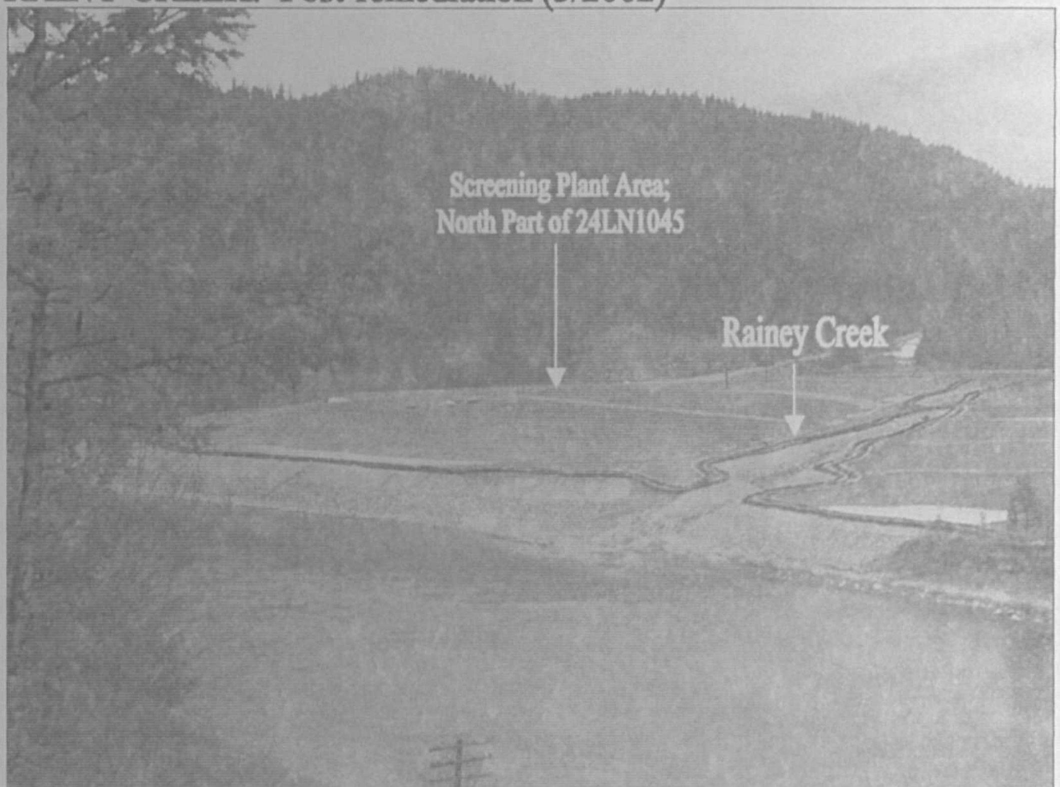

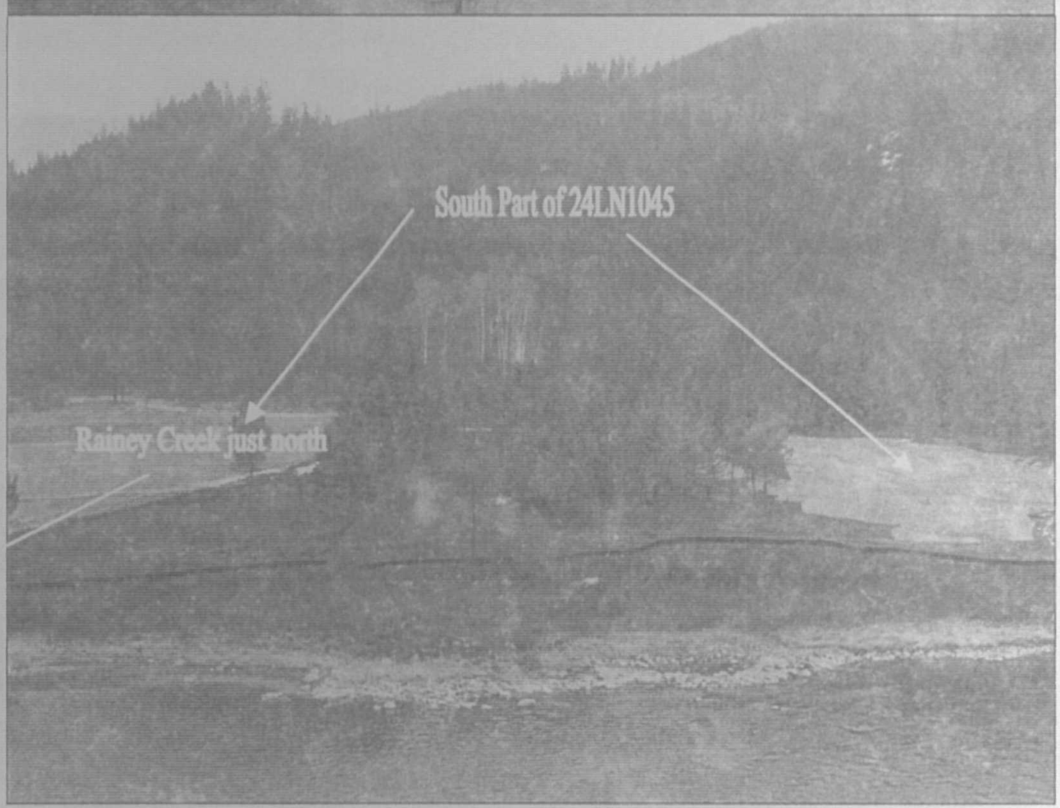

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